Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

MARCH 1952

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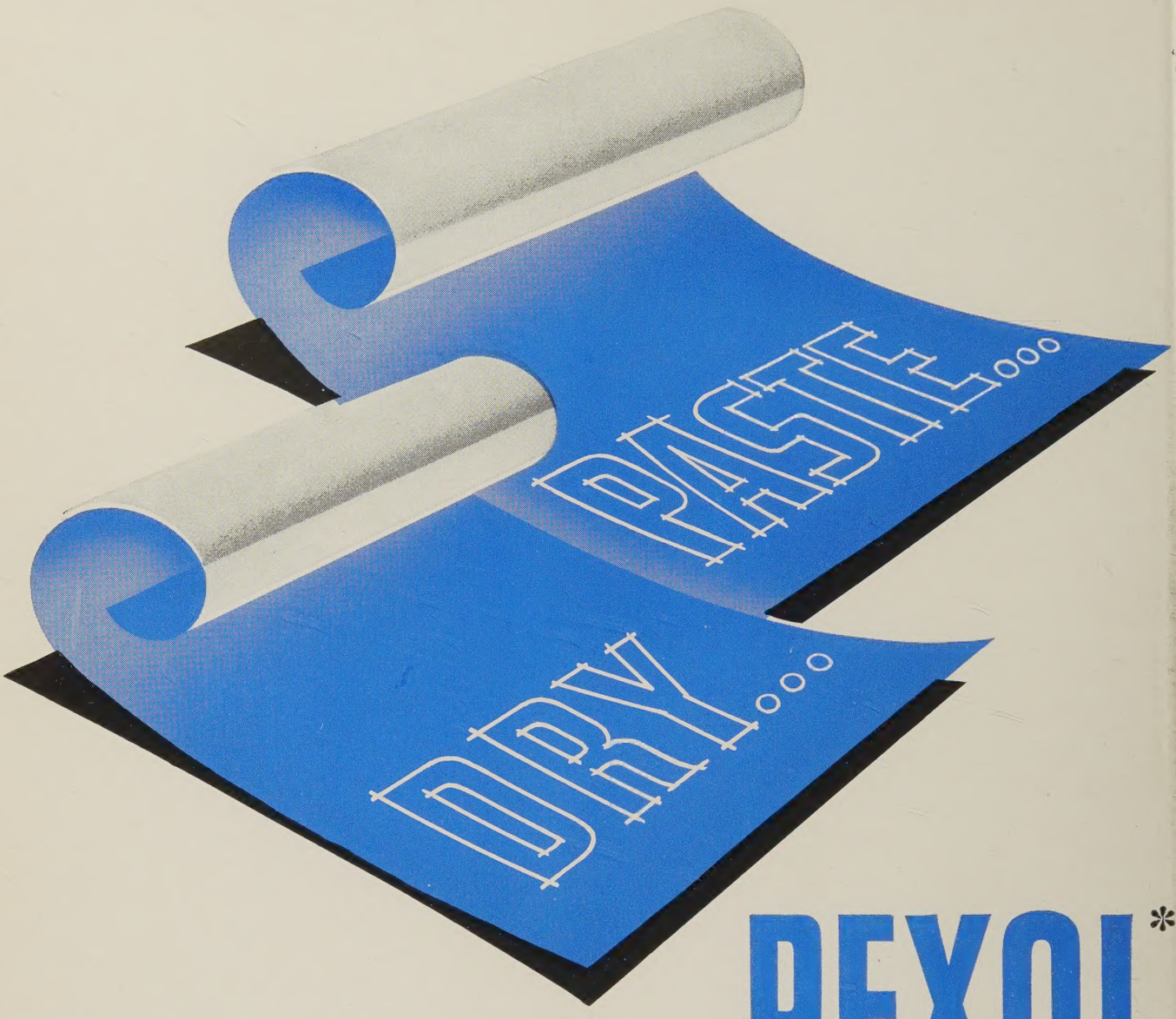

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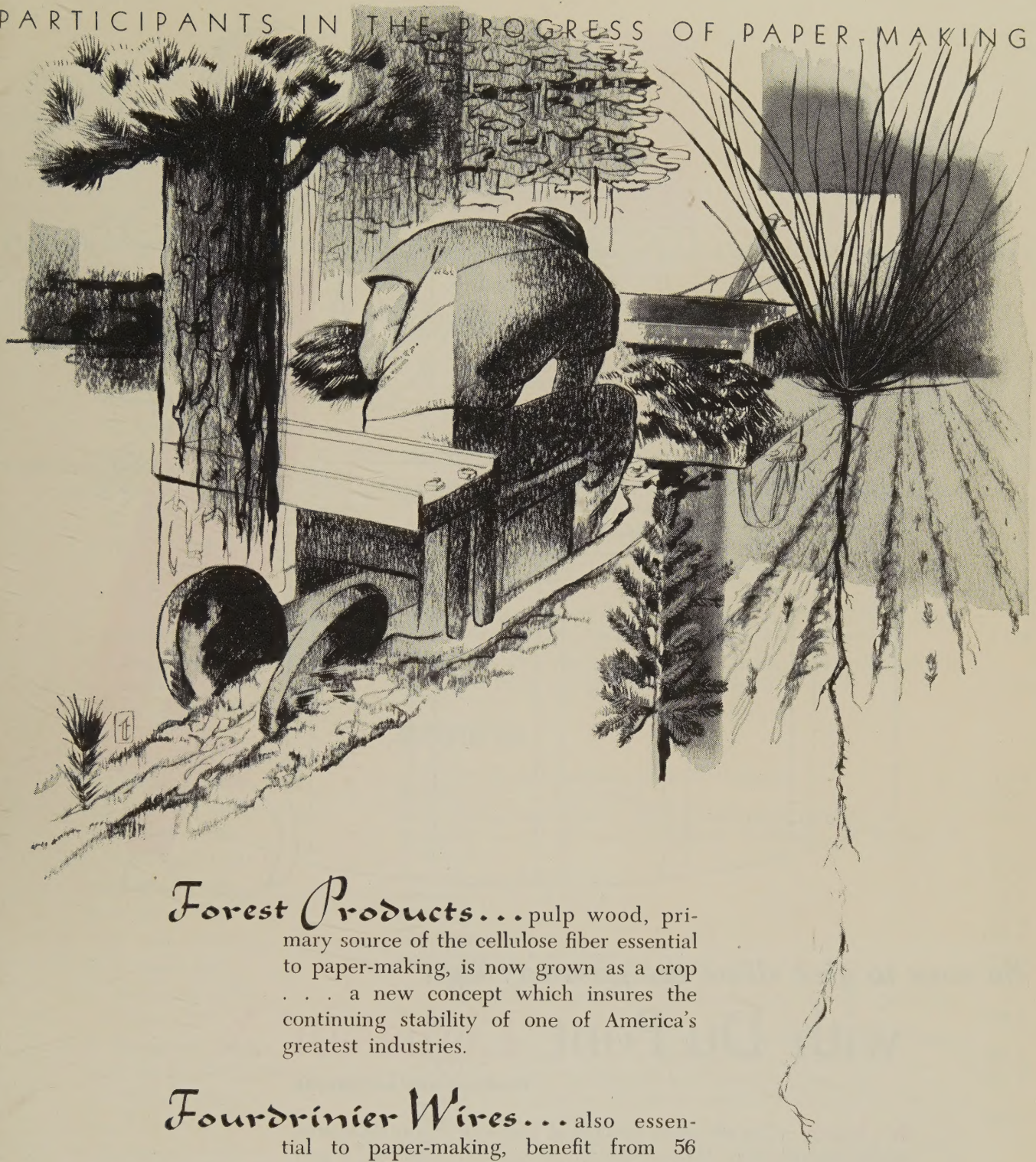

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MARCH 1952

Tappi

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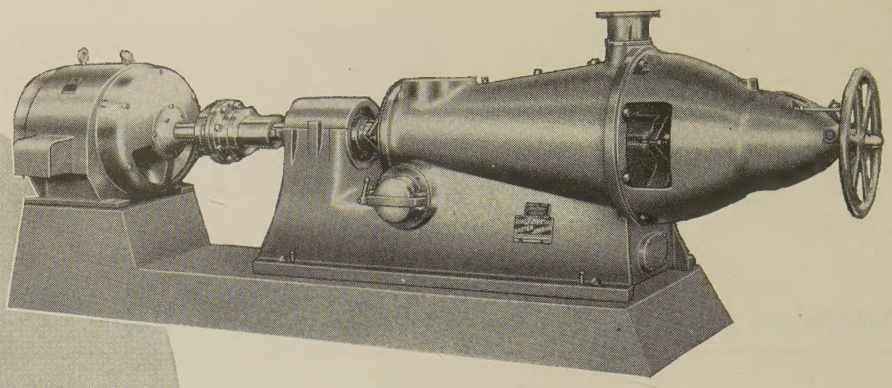

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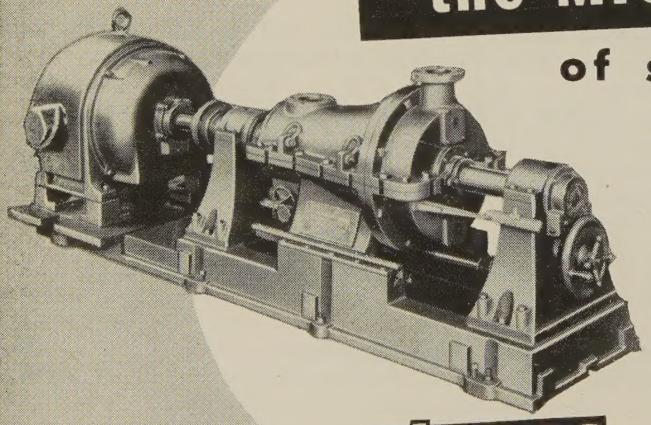

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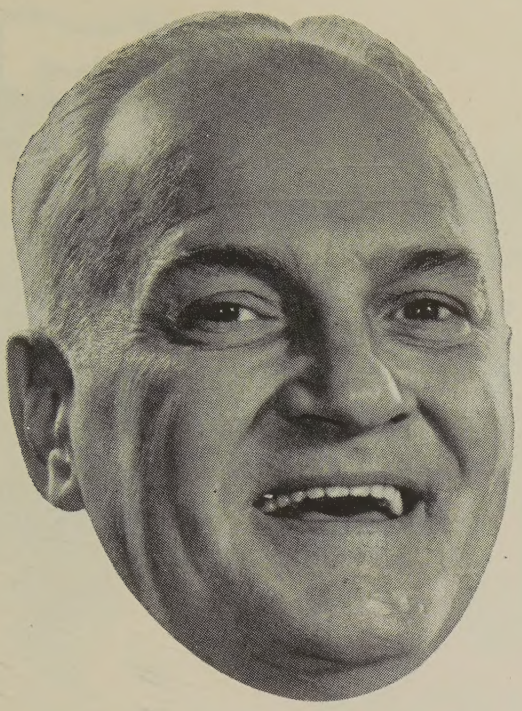

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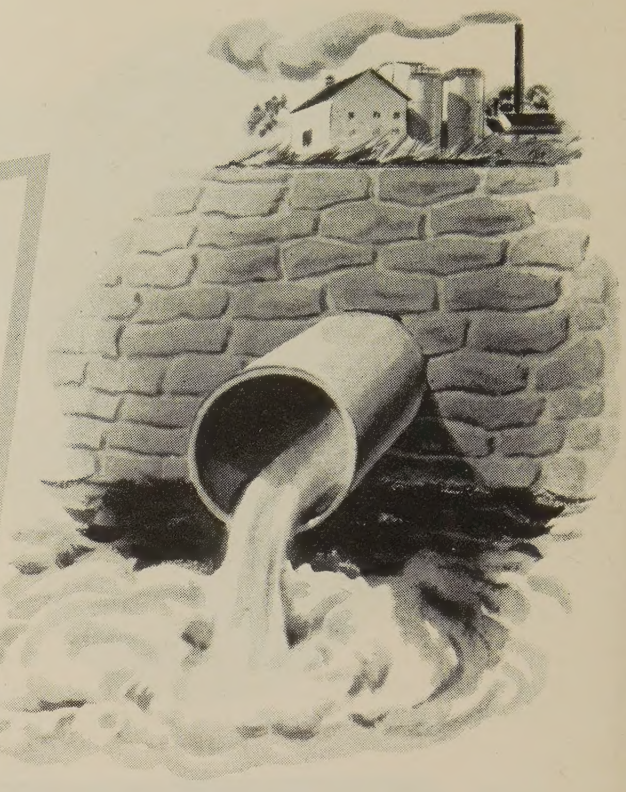

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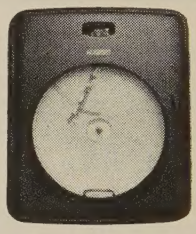

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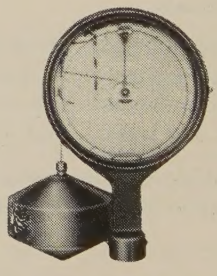

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P-759

THE PRESIDENTIAL ADDRESS

This morning I would like to talk about a characteristic of papermaking that I feel is largely responsible for the growth and development of TAPPI and that I feel holds the key to TAPPI's future.

However, there is one thing that I would like to make clear before I start. In speaking of "papermaking," I am referring to everything that goes into the production of the finished paper including pulping, the cooking of rags, straw and waste paper, finishing, converting, research, engineering, and contributions toward the development of specialties by some of the representatives of paper merchants.

When two or more paper men are together, what do they discuss? They may start with politics or tell questionable stories, but it isn't long before they get around to papermaking and thus they spend the rest of the evening. If you question this, ask their wives.

Here is another example. I was in the audience waiting for the performance to begin when I saw someone holding a program up to the light. A paper man of course, looking for the watermark.

What is the fascination of papermaking that makes its followers carry it with them even in their moments of relaxation?

1. To begin with, I think that much of the fascination of papermaking lies in its complexity. In spite of all we have learned, we are a long way from understanding all of the many factors involved. If we understood them fully, the fascination would be gone.

We wish to develop a paper for a particular use, so we decide what characteristics we think it should have. Then we choose a furnish and prepare it according to our best estimate of what is required to give the qualities we want. We control the formation, pressing, drying, tub-sizing, and calendering according to what we feel is required; and we may add a separate operation such as supercalendering, coating, or laminating if we feel it is desirable.

When the paper is finished and we test it or try it for its intended use, the probability is in favor of our finding that one of our guesses was bad; and we try again. Discouraging? Perhaps, but as I intimated above, that is part of the fun, and it puts a premium on ingenuity and a good understanding of the variables in papermaking. Certainly, if we had known in advance exactly what would happen, the experience would have lost its zest, much as the recruit from the hills of Tennessee found target practice boring because the gun had sights.

One thing is sure. When we consider that the difference between success and failure in making a suitable paper may lie anywhere from the selection of trees in the forest to the final finishing operation, none of us need worry that in our lifetime or that of our children, papermaking will be so well understood that it will be monotonous.

2. Do you remember the jig-saw craze? Newspapers print daily cross-word puzzles. Some publish double-dummy bridge problems. At least three companies connected with the paper trade used to include in their monthly houseorgans puzzles of a mathematical or similar nature. When they stopped, I really missed them.

Some people prefer one kind and some another, but most of us get a keen enjoyment from puzzles of some sort, for the desire to accept the challenge and the satisfaction that comes from solving them represent a characteristic of mankind that has been essential in its successful struggle for survival.

Undoubtedly this characteristic existed long before one of our prehistoric ancestors became the first man to dig his own dwelling place when he found that all of the natural caves were occupied.

So, the challenge posed by the problems of papermaking and the satisfaction in solving them appear to me to supply the second reason why we get so much enjoyment from our work. Every step in the process presents an endless number of a variety of problems; and we approach any one of them with a sense of adventure based on a new set of conditions from which we may arrive at a wholly unexpected conclusion.

To meet the challenge and to solve the problems, we must be prepared with a background of our own experience and that of others, and we cannot neglect any source of information that may shed a little light along the path we are trying to follow. Moreover, we must keep our minds open and guard against any preconceived notion of what conclusion we should eventually reach.

3. Everybody enjoys an argument—of the right kind. When I was at school, it seemed to me that the really worth-while discussions took place not in the classrooms but in the lockerrooms. True, the classrooms were necessary to furnish the knowledge required to make the lockerroom arguments worth while, but it was in the latter that there was real freedom of thought.

Such a discussion gives us an opportunity to match wits with our friends; it gives us an opportunity to appreciate other points of view; it helps greatly to clarify our own ideas; and it adds to our knowledge—all in a very enjoyable way.

Here is the third fascination offered by papermaking. It furnishes countless bases for discussion. Moreover, in each discussion we feel that the exchange of ideas,

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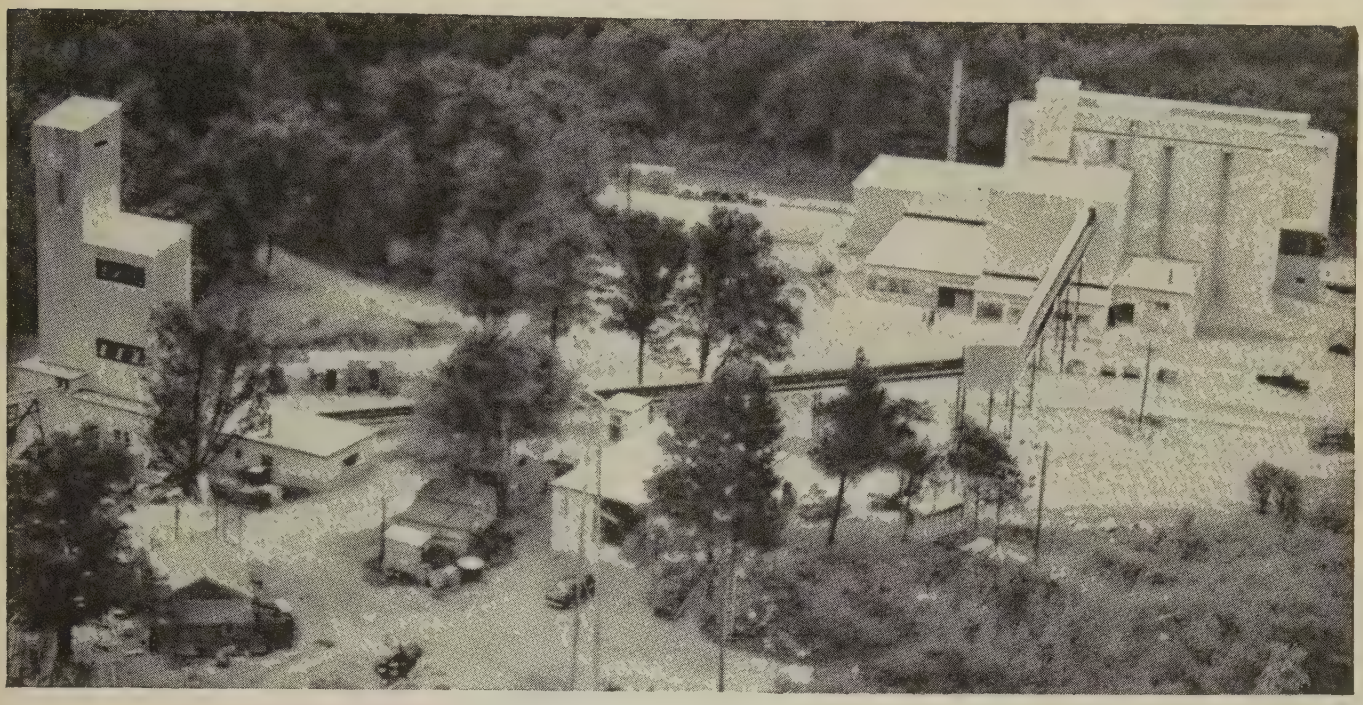

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whether we accept all of them or not, has brought us closer to the truth that we seek.

To benefit by such a discussion we must be ready to accept the fact that even our pet idea may not appear logical to others and that they may be more nearly right than we are; we must be willing to concede our own mistakes when we see them; we must make a definite effort to understand the others' points of view for they would not think as they do without a good reason; and above all we must realize that a discussion is impersonal and not carry away from it the slightest feeling of personal antagonism.

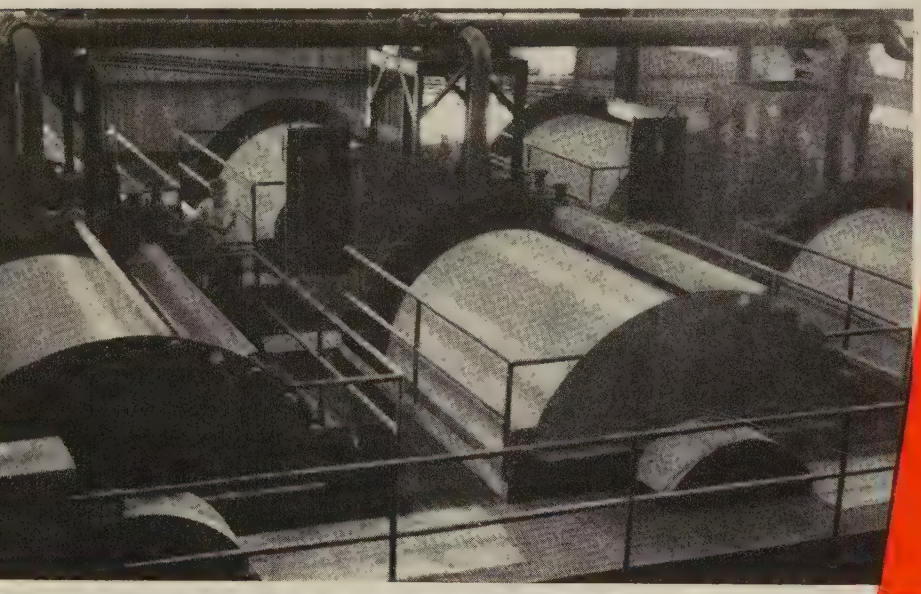
From such friendly arguments have come some of the ideas that have been of the greatest value to the industry.

4. What I have already said about the fascination of solving problems applies also to research, the fourth and last characteristic that we will consider. But there is a difference. In solving the type of problems I mentioned above, we are seeking the explanation of the result of a set of conditions that are fixed in advance. In other words, the rules of the game are set; but in research the sky is the limit and no holds are barred.

Here we have the thrill of pioneering in an unmapped country, spiced with constant anticipation for we never know what we may find around the next corner. It is easy to see why men devote themselves to research with little regard for the rest of the world.

Successful research requires as careful preparation as any explorer ever made before starting on a journey. Just as he must prepare for any eventuality, the research worker must have an almost limitless supply of knowledge. Much of it may never be used, but the most insignificant bit may mean the difference between success and failure.

Now we have defined and described four characteristics that I feel explain the fascination that papermaking holds for those that make it their life's work. These are: its complexity, the satisfaction that comes from solving its problems, the opportunity it furnishes for



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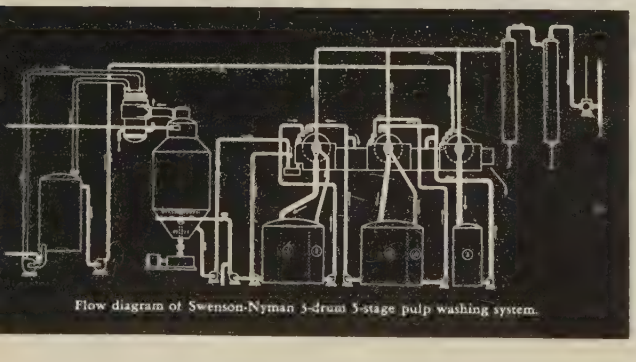

Flow diagram of Swenson-Nyman 3-drum 3-stage pulp washing system.

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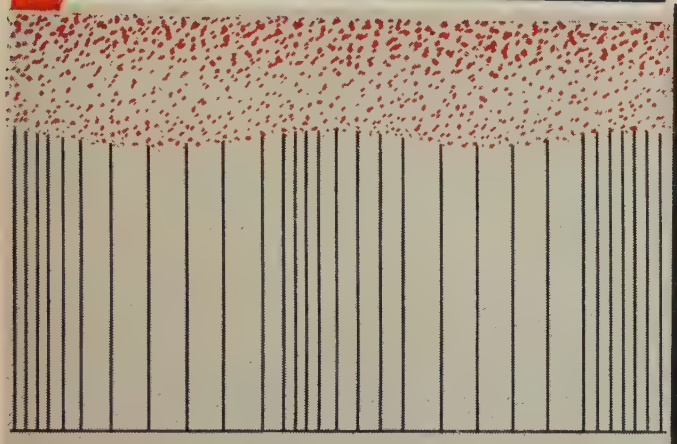

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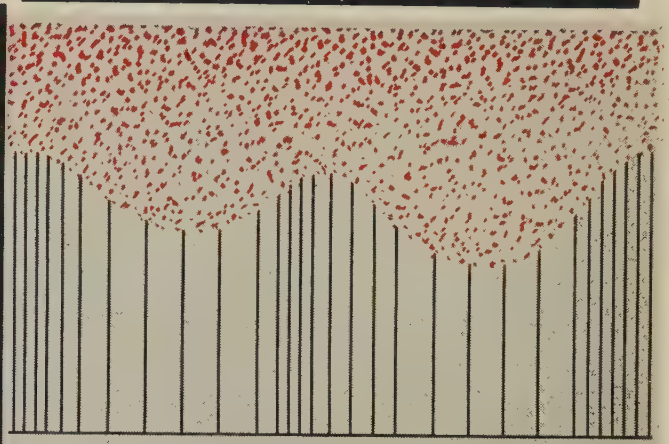

Note that where application of adhesive is uncontrolled, the variation of adhesive penetration is in proportion to the variation in porosity of the paperboard.

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informative discussions, and the opportunity for research. Let us see what effect these have had on the development of TAPPI and their relation to its future.

Why is TAPPI so outstandingly successful? The success of any association depends upon the degree to which it meets the needs and the desires of its members. If this is so, and if we are right in our assumption that the characteristics of papermaking we have listed represent the interest of our members, we should expect to find that TAPPI's development has been in accordance with the ideas we have discussed. Let us see if this is so.

1. First we called attention to the complexity of papermaking. What does TAPPI do to give its members the best possible grasp of this complex subject, to permit them to study the intricacies of each of its phases, to keep abreast of new developments?

It encourages the preparation of papers on various phases of a wide variety of subjects, and provides an opportunity to present and discuss them at its annual meeting and functional meetings.

It publishes these and other papers. Originally they were published in the *Paper Trade Journal;* but now they appear in our own publication, *Tappi.* They are selected carefully and edited by foremost authorities. Provision has been made for supplying each year's papers bound for permanent reference.

It publishes monographs on various phases of papermaking. These are prepared and edited by members of our committees.

The TAPPI Standard Testing Methods are accepted throughout the industry; its new Routine Control Methods are meeting with an enthusiastic response.

2. To meet the need of the man faced with a problem in an unfamiliar phase of papermaking, TAPPI publishes its bibliographies. These list the papers that appear in TAPPI and in other publications throughout the world, as well as books and patents pertaining to papermaking.

All of us who have had occasion to use these bibliographies realize the debt we owe to C. J. West who prepared them and is thus responsible for one of our most valuable tools.

3. A forum for open discussion is provided by our annual and functional meetings, and in the meetings of our local sections. The latter permit participation by members who are unable to leave their work to go to New York or to the cities in which the functional meetings are held.

In these local meetings, members gain the pleasure and inspiration that comes from a free, informal discussion in addition to hearing papers on subjects of interest to them. At the same time, they learn to know TAPPI personally and to enjoy the comradeship of a group of men working together for the good of the industry.

4. TAPPI's committees promote and carry on research and experimentation on an industry-wide basis. Much research throughout the industry is carried on by individuals on a company basis, but even here TAPPI is of assistance through its publications, its bibliographies, and the work accomplished by its committees.

The work of TAPPI's committees offers benefits that are lacking in company projects. Here is an opportunity to develop the ideas of individuals who are not primarily engaged in research work; here, through committee discussion, ideas originate that might never have been conceived by an individual; here any member of TAPPI can submit an idea, be sure of thoughtful consideration and constructive suggestions, and count on cooperation in developing it if it appears valuable.

One's hindsight is always better than his foresight; and it is easy to predict what already has taken place. Even so, I cannot help but feel that by considering the four characteristics of papermaking that we have discussed, we should have been able to predict the services TAPPI has initiated to meet the needs of its members.

On the same basis, we should be able to predict the steps we should take to assure TAPPI's future progress. Let us attempt this.

First, however, I would like to make a comment. TAPPI has been successful because Mr. Macdonald has understood the needs of its members. True, the decisions have not always been his; but he has furnished the continuity and the vision. The credit is his.

We have every reason to feel that his guidance in the future will be just as effective as it has in the past. Then doesn't it seem a bit presumptuous on our part to attempt to say what should be done to assure TAPPI's success?

I do not think so, because I know that the statements I am about to make coincide with his judgment. They could hardly be otherwise for they are broad statements and may seem too obvious. On the other hand, I believe that they are worth while for they point out how we can support Mr. Macdonald in his efforts to improve the services of TAPPI.

Let us state them in the same order we have followed throughout; and as I read them, I would appreciate it if you would consider whether you can give more help in any of these fields.

1. Do everything we can to assure the continued success of our publication, *Tappi*, both financially and in maintaining the same high quality of its articles. Prepare more monographs. Prepare new standard methods and review the old ones to bring them up to date in light of recent knowledge.

2. Support the preparation of our bibliographies.

3. Do all that we can to strengthen our local sections and to assist them in bringing to their members the advantages of discussion and attendance at meetings.

4. Provide assistance to our committees that will prevent duplication of effort, initiate investigations to fill the blanks in our knowledge, and try to make certain that their research is on a sound basis.

We are fortunate to have our life work centered in an industry so fascinating as papermaking. We are fortunate that our efforts to better the efficiency of our companies and to raise the standards of our industry become an interesting adventure. And we are fortunate to have an association that does so much to help us and to broaden our knowledge in all branches of papermaking. Let us all give it our wholehearted support.

K. P. Geohegan
President of TAPPI

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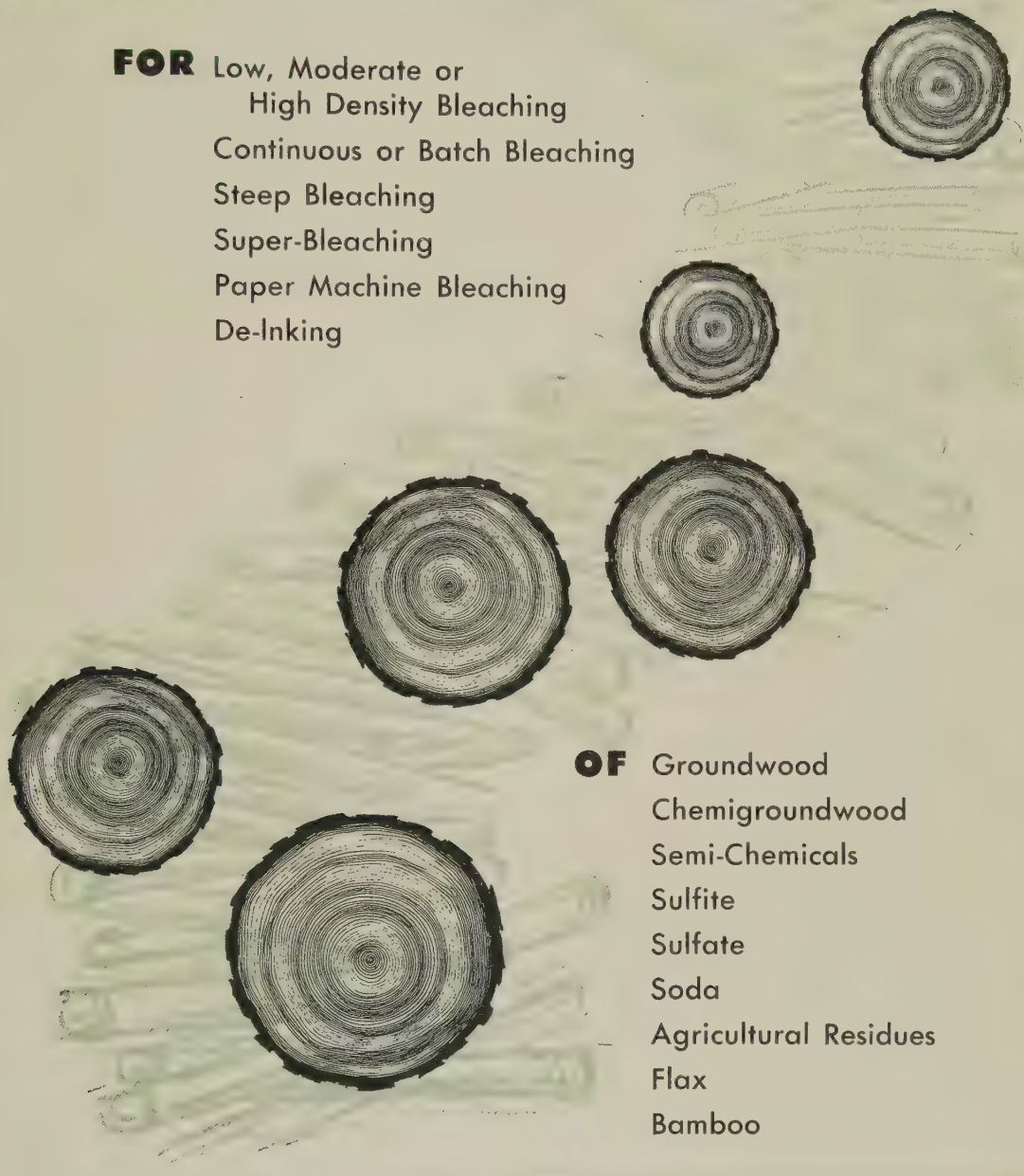

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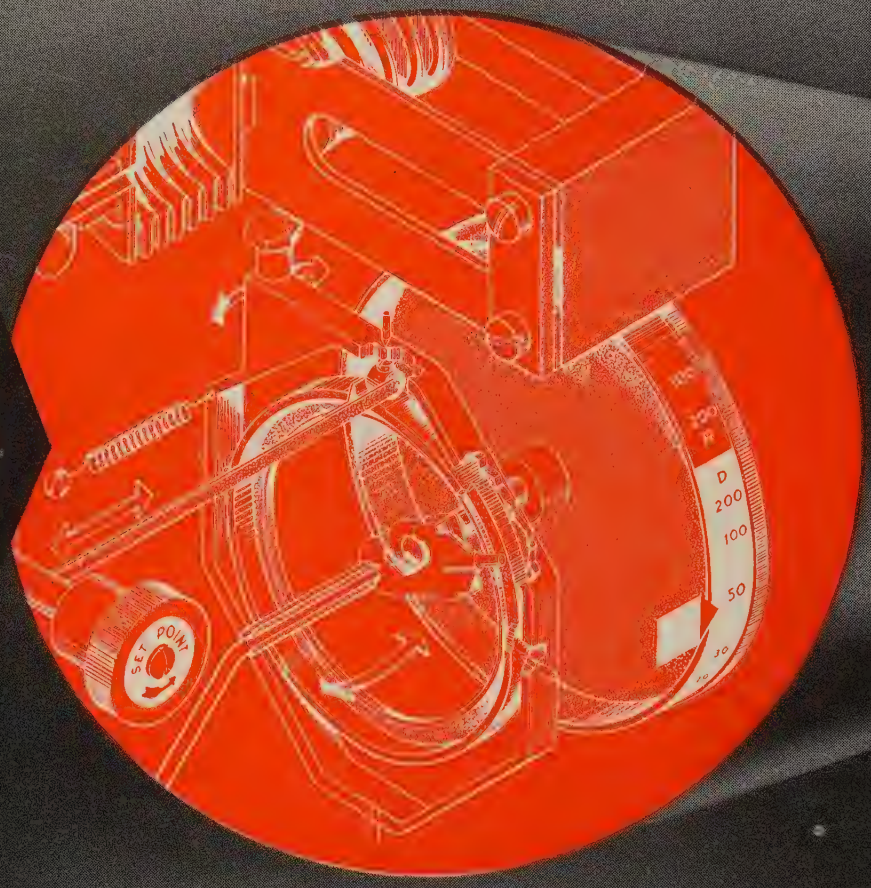

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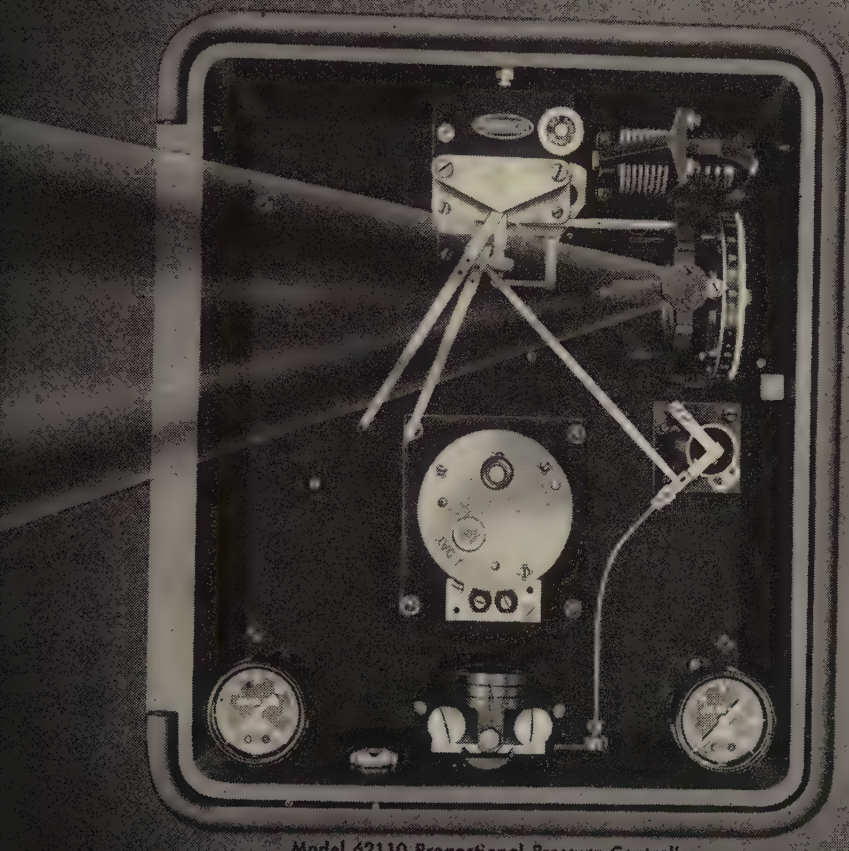

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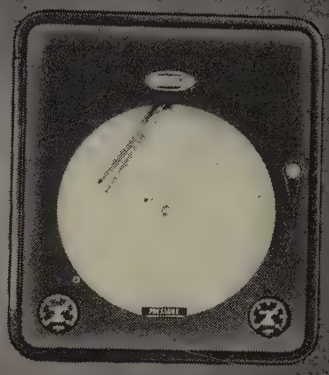

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Values

R. G. MACDONALD

President Sangren, Mrs. Durham Mohr (Chairman, Michigan Board of Education, Graduates of Western Michigan College, and friends:

It is with genuine pleasure that I join with you today to receive an academic degree from this fine institution. The invitation to speak to you on this occasion is appreciated and it is with humility that I undertake the task of participating in this ceremony. It has always seemed to me that this particular place in the program has been reserved for individuals trained by experience in oratory such as educators, clergymen, lawyers, or politicians.

Although it has been my lot to talk to many groups over the past twenty-five years, they have, for the most part, been men who have had a common interest in the technology of pulp and paper manufacture.

The establishment by Western Michigan College of a pulp and paper manufacture curriculum was a brilliant innovation instigated by someone with real imagination and foresight.

Education in the paper industry, in the modern sense, has been a rather recent development. At the end of the first World War there were but one or two texts dealing with the subject as a whole. In 1918 a group representing the industry in the United States and Canada got together as a Joint Committee on Vocational Education and produced a set of five textbooks on the Manufacture of Pulp and Paper. About this time the University of Maine established a pulp and paper course. Later the New York State College of Forestry followed with a similar course, and in 1929 The Institute of Paper Chemistry was established at Appleton, Wis., as a graduate school. Your school has therefore joined the pioneers in a forward looking movement.

Today presents an unusual occasion, marking the passage of an era and the dawning of a new one. It denotes a time when you are suddenly asked to accept a status of maturity in which straight thinking is of paramount importance.

When I received my baccalaureate degree, the path ahead seemed much simpler than it is today. Getting any kind of a job was of first importance. Then, the schedule of advancement was relatively slow. There seemed to be a surplus of manpower. Under such circumstances the procedure for the first few years was quite definite. A medical doctor served an internship; a lawyer entered a law office as a clerk; and an engineer served an apprenticeship as a cadet engineer for the purpose of orientation and adaptation to the industrial way of life. There seemed to be plenty of time for the leisurely pursuit of these objectives.

Today, a student graduates and under the conditions of the present manpower shortage, he is expected to skip much of the training period and enter into pursuits carrying much more responsibility. The medical student is urged to enter the military services, the scientist is wanted by the government, industry, and the university to carry on research and the engineer is expected to start designing, building, and operating industrial plants. Many of you as potential educators already know what is expected of you.

You have been trained to teach. In whatever form this practice will take, you must aim to be educators. Education for good or evil is moving along rapidly today by means of the spoken word, the printed word, and the picture.

Of the printed word we speak further, for education, paper, and the graphic arts are genuine kinfolk. All are handmaidens of civilization, as we know it. It has been said that the per capita use of paper is an indication of a nation's civilization. For Americans this is a pleasant supposition since each of us uses 350 pounds of it each year. In contrast there are other large countries using less than 5 pounds per capita.

Whether this assumption is true or not depends on the yardstick that we may use in measuring our cultural advance. Such a criterion leads us to a speculative consideration of values.

The engineer and the scientist in their respective professions have the easiest job in determining values, especially as they relate to material things. Basic things such as dimensions, weights, and time can be measured quite accurately. Our National Bureau of Standards and other scientific archives actually preserve yardsticks and international meter lengths and instruments for estimating time and the influence of terrestrial gravity. The libraries are filled with books and manuscripts revealing careful measurements and data relating to material values.

In these days of growing inflation and even of the fear of deflation we are confronted with the problem of determining the value of real wealth. The possession of money, including the gold at Fort Knox, securities, real estate, and many other traditional criteria may not always be a satisfactory measure of real wealth. Food, clothing, and shelter are said to be the fundamental basic needs of man.

During and after the recent war there was a great surplus of potatoes in this country. You remember the scandals relating to their disposal by burial. In defense, government authorities pointed out that they were too bulky and contained too much water for economical shipment. Wheat was the preferred commodity, meeting such conditions.

Wheat appears to have been the important yardstick for measuring the standard of living over the

R. G. Macdonald, Secretary-Treasurer, Technical Association of the Pulp and Paper Industry, New York, N. Y.

Note: This address given at the Commencement Exercises of Western Michigan College of Education is printed in response to a large number of requests. Since the occasion was a recognition of the educational services of the Technical Association as well as the interests of the speaker it appears appropriate to publish the address as a matter of record.

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years. At least we have better records relating to this commodity for a longer period of time than for any other. Records exist that show wheat production in Great Britain during the Elizabethan era. At that time a man needed to work $6^1/_2$ days to purchase a bushel of wheat. Today, an average laborer in this country can earn a bushel of wheat in $3^1/_2$ hours and some earn it in $^3/_4$ of an hour.

What does this comparison mean in reference to a value such as a standard of living? It means that the application of science and engineering to the production of a commodity containing nearly everything to maintain life has released time to mankind for uses of his own choosing. In fact, it can be said that man would have little opportunity to fight in modern wars unless he were released from the toil of producing food. This is accomplished through the medium of mechanization of the farm.

In releasing mankind from drudgery by developing mechanical and electrical enegy as a substitute for human toil, time has been made available for leisure. The use to which this leisure is put is of great importance. It introduces the need of establishing intangible values. In your studies, I am quite sure that you have devoted much effort to analyzing these values and arriving at your own conclusions as students of religion, philosophy, history, sociology, psychology, literature, the fine arts, music, etc. There is need for intensified studies in all of these important fields.

Again when we think of the value of wheat it is common to think of it in terms of unit-price. What determines its price? Supply and demand are part of the answer. There are, however, other economic aspects. Like everything else that is produced by human effort the hourly value of a man's time is a major element of cost. Although the farmer may not always work at so many cents per hour, he is guided by the income that he would receive if he were engaged in some other occupational pursuit. In fact, the term "parity" about which you have heard but may not fully comprehend is a price for certain commodities based on the farmer's cost of living and the price that he must pay for certain things that he buys, including machinery and products made on machines.

Today, in this country, the value of a man's contribution of time to the production of goods is established on a minumum basis by federal and state laws. We can think of the farmer as working at labor rates of compensation. He plows the field, sows the grain, cultivates the soil, and reaps the harvest. At one time he did all this aided only by draft animals and in some places today many follow this routine. In the process of farm mechanization, generated horsepower has replaced much of the work formerly considered to be a chore for men and horses. The costs of labor, rent of the land, machinery depreciation, transportation, and profit are all elements that determine the price of the wheat to the consumer.

The fact that one man with mechanical aids can produce in 1 hour as much as can be produced by many men without mechanical aids means that many men do not have to be engaged in wheat production but can be employed in other ways. In some countries five out of six men need to be employed to feed all six. Our great American industries could not function in a war or peace economy if machines did not make possible the feeding of six men by the farm labor of one man. This is the basis of the high standard of living in this country and explains why so many people have so many things to make living more enjoyable.

With all of this material progress we find much unhappiness in the world and even here at home. We find much human unrest, frustration, and dissatisfaction. There are frequent evidences of unrest in industry. Why is labor often unhappy? Certainly problems of wages and hours are not all of the causes. Wages could be doubled and hours of labor halved and any happiness derived thereby would be short-lived. It is more than this. It is the need for self-appreciation; the creative urge that is common to most of us; and the need of feeling that the thing that is being done is worth doing.

In these days of mass production the man who is putting a nut or a bolt on one machine after another needs to know that he is doing something worth while and is making a contribution to society. He needs to know wherein he fits into the economic system and into society. He needs to know that his effort is providing leisure and pleasure for his fellow man.

There is an important job to be done in this field of human relations. It needs to be carried out by individuals who have a complete understanding of their objective. The facts need to be catalogued and interpreted for the benefit of the men carrying on the production job, whatever it may be. The engineer who has created the job and the tools for expediting it is in the best situation to interpret these facts and to advise the workman. To a large extent the engineer has defaulted in meeting this responsibility of improving human relations and has shrugged it off, feeling that he has done all that interests him, in creating the job opportunity and the tools of its accomplishment.

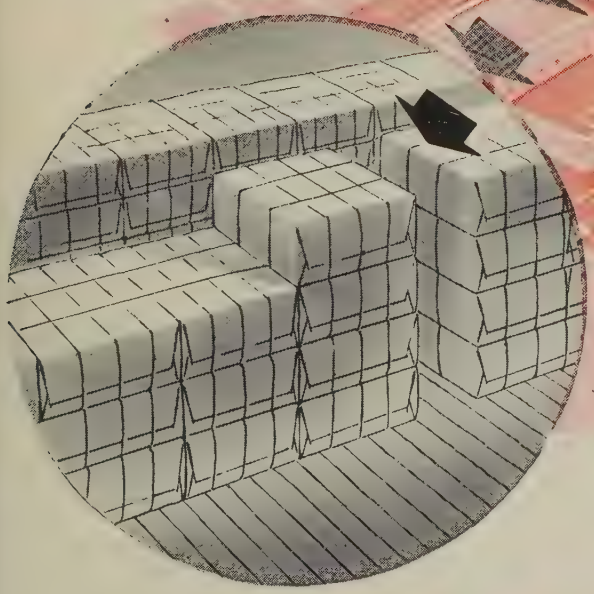
Industrial management has recognized the problem and has endeavored to solve it by employing so-called "human relations experts." This has been a partial solution of the problem but not a complete one. As a result of this incomplete treatment there are many volunteers who recognize this deficiency and are eager to establish thoughts in the minds of uninformed and sometimes bewildered individuals. Such trail-blazers represent organized labor, the clergy, educators, politicians, sociologists, and even groups that we are inclined to term as subversive.

Their proposed solutions all differ in methods of dealing with the problem which I will again state as, first, the desire to be doing something of measurable value to mankind and second, the craving to be loyal to something and somebody. These are two great values that need to be understood since they now have and at a future time will have an important effect on you and me.

You, as educators, have no time to serve an apprenticeship or an internship. You need to engage in research right away since the manner in which these values is determined and its relationship to your thought processes have a direct bearing on your way of life. It will also affect the way of life of future generations. The direction of mass thinking will decide the fate of free enterprise, socialism, communism, and other mass appeals. The problem is not a simple one, for as we

"Packaged Mills"

mean more woodpulp



Close integration of the various wood-processing plants at a Weyerhaeuser Timber Company mill and full diversified manufacturing are very much evident in the company's pulp manufacturing centers. Improved technology at the mill site, with greater accent on better utilization of what was previously considered waste material, is a real answer to a permanent forest industry.

Weyerhaeuser's sulphate mill at Longview, Washington, is a step forward in whole crop utilization. In this manufacturing center, sawmill left-overs and logs not suited for lumber are converted into sulphate pulp. The Kraft pulp mill utilizes Douglas fir slabs, edgings and trimmings from the sawmills and Douglas fir peeler cores from the plywood plant. Many technological advances make this process economically sound. Not the least of these is a hydraulic barker for saw logs, which means that bark-free milling left-overs now can go directly to the chipper without further handling.

"Packaged Mills", supplied by well managed "Tree Farms", will provide the Pulp Division, Weyerhaeuser Timber Company with more and more woodpulp in the years to come.

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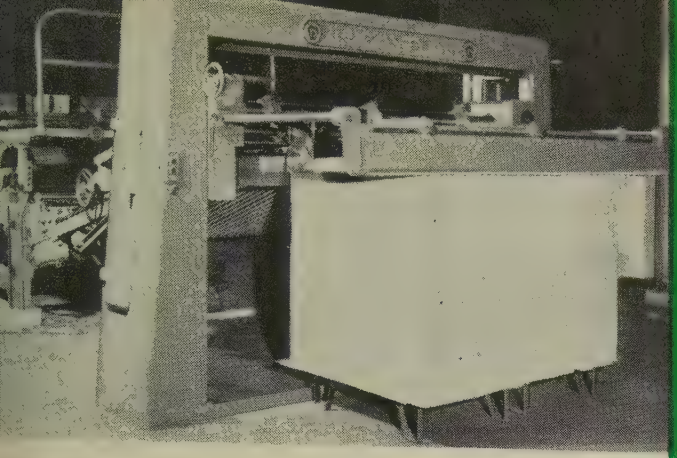
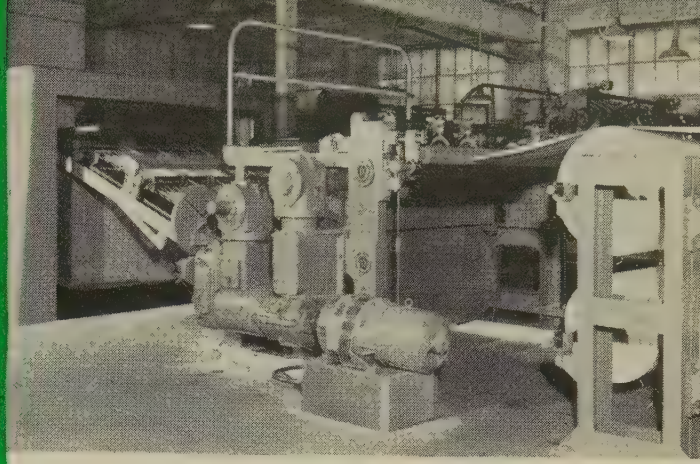
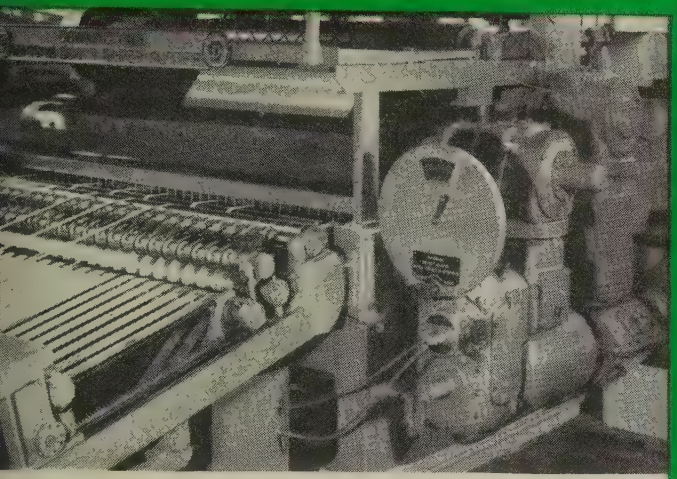


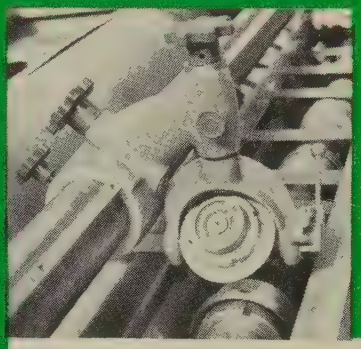
e overlapping layboy piles the sheets from the floor level upwards ermitting high stacks with the cutter itself located close to the floor.

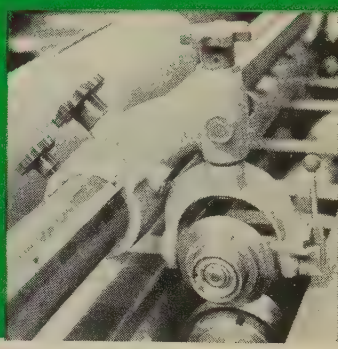


The drive, in totally enclosed oil lubricated units, is fastened directly to the cutter frame and is easily accessible.



Another view of the drive side showing adjusting mechanism.





The rack and pinion movement of the top slitter units and the hand-wheels for the depth and angle of engagement can be seen in the photographs above. (Right: engaged. Left: disengaged.)

The Downingtown Masson-Scott Super Cutter and Layboy is a high speed, precision sheet cutting machine developed by Masson-Scott in England over a period of years. It is now manufactured exclusively in this country by Downingtown. The Super Cutter and Layboy is capable of a high rate of production, yet maintains a degree of accuracy not previously associated with rotary sheeting equipment. The machine is precision engineered for sustained high operating speeds. The specially designed cross cutting knives permit an exceptionally clean cut through heavy combined substances. Write for Bulletin No. 252 which describes the Downingtown Masson-Scott Super Cutter in considerable detail.

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DOWNINGTOWN

MASSON-SCOTT SUPER CUTTER AND LAYBOY

look around, we find examples of great nations devoting themselves to these and other schools of thought. It calls for clear thinking based upon facts.

The technical approach to obtaining facts is routine. It follows the procedure of experimentation, measurement, qualified observation, analysis of data, and interpretation of these data, scientifically obtained. We are living at a time when major social experiments are being carried on. The political leaderships in the countries participating in this great research effort are strong enough in most cases to provide much of the data needed for future action. The opportunities that have made these experiments possible have been the great voids created by wars and, in a sense, revolutions.

In this country, at least, as long as we have a free press and means of communication it is possible for each of us to observe these experiments and to arrive at conclusions which we can express at the ballot box. The problem is to get accurate and honest information and to be able to separate the wheat from the chaff. I do not doubt that the average man wants to know the truth and will act in accord with his conception of it. If he seeks the facts he will have both authentic information and specious propaganda offered him. How can he know which is which? What will you be able to do to guide his thinking in the direction that you feel is the truth?

Is the answer "common sense"? If so, this country and most countries have an abundant supply, for all of us feel that we are well endowed with this faculty. In spite of this, there is evidence of a disturbing increase in mental illnesses, largely based on social complications and frustrations. One facet of common sense is intuition. Many of the early philosophers used this approach in their analysis of natural phenomena. They were followed years later by the alchemists who assumed that all matter existed in four states: earth, air, fire, and water and a fifth state which, for want of a better term, they called the "quintessence." It was that certain something that added life or what they thought was life. Strangely enough, the alchemists are held in ridicule because they advanced the concept of transmutation of base metals into gold. We are inclined to consider them as being charlatans since many of them made their living by being financed by patrons who hoped that they could do this. Today, the advances in the field of atomic energy have made the alchemists' dream of transmutation of metals come true. They were followed by the phlogistonists who believed that matter gave up something when it was burned. The scientists, by using measurements found that something was added to matter when it burned. For example, when lead was burned it changed to a yellow powder. The phlogistonists believed it lost something. The scientists weighed the lead before and after it burned and noted air increased in weight.

In contrast to their predecessors, the present-day scientists feel able to draw conclusions because they accumulate facts and profit thereby. Their conclusions are based on experimentation and the analyses of data resulting from these experiments. They feel that those who are directly concerned with other phases of our social system should apply such methods to their own problems. In following the tried and proved tenets of science namely, intellectual honesty combined with education and experience, leaders of thought should arrive at conclusions in which they have confidence. They can then present educators with the teaching tools necessary for straight thinking on the part of the individual.

All of the efforts of our scientists, our educators, our men of government, our religious leaders, and many others cannot hope to solve the problem. The solution must and does, rest with the individual. It is he who must undergo a moral and spiritual revolution. When that is accomplished and we multiply him by millions of others like him, then, and only then, will we come to the point where we may all continue to advance together.

Up to this point, I have dealt with materialistic concepts of values that are of current consequence and can be established by research effort. The social sciences are still in the phlogiston stage. Although they never will be as exact as the physical they can be more exact than they are now.

The disproportion in the advance of social sciences has given us a lack of real ways of measuring a man's capabilities, which in turn has forced the labor unions to insist on seniority as the sole criterion of promotion.

The belief that only material things count has caused a widely prevalent prejudice against nonmonetary rewards. It is agreed that such rewards should not be a substitute for wages, but we must feed the soul as well as the body. The prejudice is just as inherent in management as in the unions. Their thinking is alike and they are quarreling only over the quantitative factors of wages, pensions, social security, and so forth. True, a good job well done is a satisfaction to the doer himself, but in most cases the satisfaction will not go very far unless ways are found to give him distinction among his fellows. Extra vacations, public acknowledgement of promotion, gifts, medals, and other awards, opportunities for education, and, above all, the personal touch, will go far to give the satisfaction which material things cannot bring. These rewards represent the antithesis of the collectivist theory, and will be opposed by levelers from both sides.

Science has been only a partial success, insofar as society is concerned, because it early fell into the hands of materialists and, hence, has had a lopsided development, which has accentuated problems without presenting means for their correction. For these reasons we have two reactionary movements; on the one hand return to rugged individualism, the law of the jungle, and on the other hand to statism in its forms of Fascism and Collectivism.

In times of stress there is a general movement in the direction of the spiritual. We are living now in times of stress and the crowded churches of all faiths bear evidence of this movement, for it is in this field where certain values are known and accepted in faith. Few of us know very much about the contents of the Holy Bible, but a great proportion of people in the Hebraic and Christian worlds know about two important texts and these are expressions of values upon which most of us would like to pattern our lives.

In the Old Testament we have the ten commandments which tell us to believe in God; believe in humanity; associate eternal virtues with God; keep the Sabbath; honor one's father and mother; aid in human conservation; practice monogamy; earn an honest liv-

SAVED in 10 months!

Photo courtesy of
St. Joe Paper Company

Six of these wood piles were saved between March and December, 1950 by a large kraft mill in the South. Actually, the mill saved more than that—a total of 26,200 cords. With this tremendous saving in wood went an appreciable increase in pulp quality. These results were obtained simply by installing a Sutherland High Yield System.

This is conservation where it really counts—in the *growing* tree—and a potent factor in the progress of the pulp and paper industry.

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ing; tell the truth judiciously; and to respect law and order, obeying their precepts.

In the New Testament we have the wonderful Sermon on the Mount. When Christ saw the crowds of people He went up on the mountain. There He seated Himself, and when His disciples had come up to Him, He opened His lips to teach them, saying:

Blessed are the poor in spirit: for theirs is the kingdom of heaven.

Blessed are they that mourn: for they shall be comforted.

Blessed are the meek: for they shall inherit the earth.

Blessed are they which do hunger and thirst after righteousness: for they shall be filled.

Blessed are the merciful: for they shall obtain mercy.

Blessed are the pure in heart: for they shall see God.

Blessed are the peacemakers: for they shall be called the children of God.

Blessed are they which are persecuted for righteousness sake: for theirs is the kingdom of heaven.

Blessed are ye, when men shall revile you, and shall say all manner of evil against you falsely, for my sake.

Rejoice, and be exceeding glad: for great is your reward in heaven: for so persecuted they the prophets which were before you.

Again as recorded in the fifth chapter of Matthew, He continued:

Ye are the salt of the earth: but if the salt have lost his savour, wherewith shall it be salted? It is thenceforth good for nothing, but to be cast out, and be trodden under the foot of men.

Ye are the light of the world. A city that is set on a hill cannot be hid.

Neither do men light a candle, and put it under a bushel, but on a candlestick; and it giveth light unto all that are in the house.

Let your light so shine before men, that they may see your good works, and glorify your Father which is in heaven.

In closing may I wish for you a future based upon those values that neither time nor any circumstance can take away—a future illuminated by understanding, love, truth, high ideals, and devotion.

An address given at the Commencement Exercises of Western Michigan College, Kalamazoo, Mich., on Sunday, Jan. 27, 1952.

Ed. Note: Following the Commencement Address Dr. Wynand Wichers, Vice-President of Western Michigan College of Education read the following citation, following which President Sangren, assisted by Prof. A. H. Nadelman completed the ceremony by clothing the candidate with the doctorate hood of Western Michigan College.

CITATION

Ronald G. Macdonald studied Chemical Engineering at the Massachusetts Institute of Technology and received the Bachelor of Science degree from that institution in 1922. Experience gained by employment with two paper companies was followed in 1926 by affiliation with the publication *Chemical and Metallurgical Engineering* as market research director. Just twenty-five years ago in 1927, he began his work as Secretary-Treasurer for the Technical Association of the Pulp and Paper Industry.

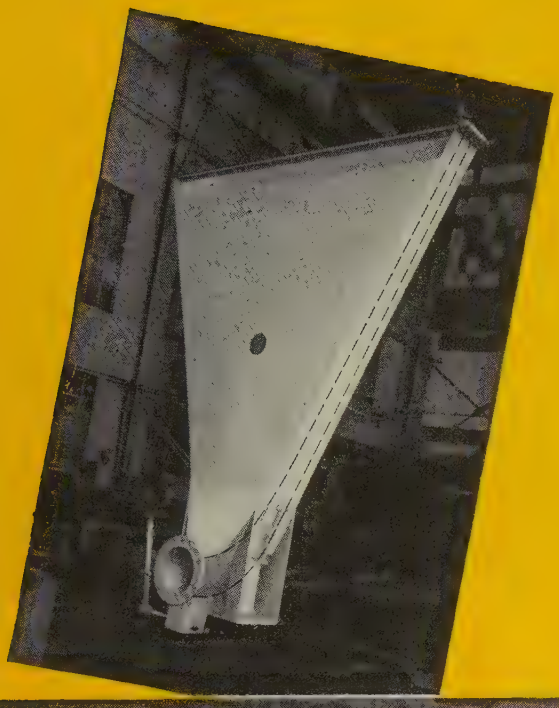
During a quarter of a century of service to the industry, R. G. Macdonald has seen to it that his Association "organized for the search and dissemination of knowledge relating to pulp and paper" carried out its important mission. His function has been largely that of a sparkplug in stimulating the spectacular growth of his association and in inducing qualified persons to contribute to the literature of pulp and paper manufacture and technology. As editor of the magazine *Tappi* he has contributed significantly to education far beyond the area of the pulp and paper industry.

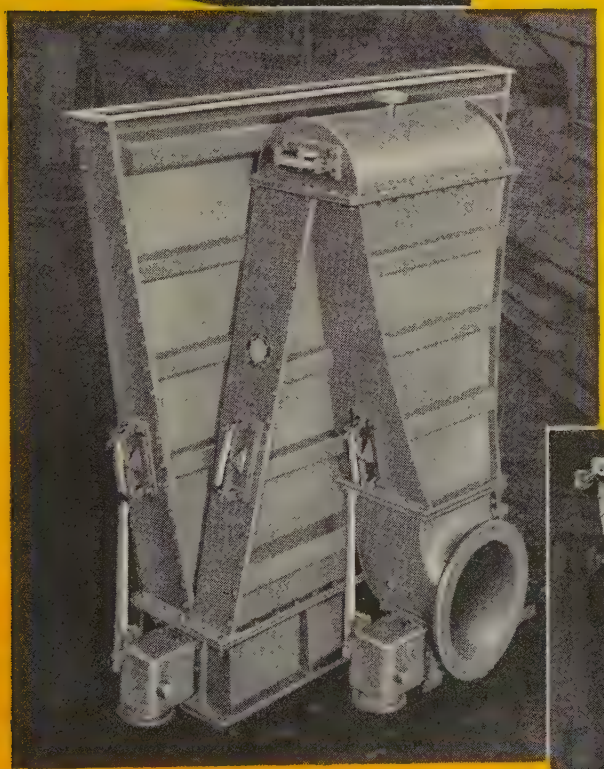
R. G. Macdonald, center, secretary-treasurer of the Technical Association of the Pulp and Paper Industry for the last 25 years, receives the congratulations of Dr. Paul V. Sangren, president of Western Michigan College, on the receipt of an honorary doctor of science degree from the Kalamazoo, Mich., school January 27, 1952. Mrs. Louisa Durham Mohr, president of the Michigan State Board of Education, looks on.

For these reasons I take great pleasure and honor, Mr. President, in presenting to you as a candidate for the honorary degree of Doctor of Science Mr. Ronald G. Macdonald of New York City.

WYNAND WICHERS, *Vice President*
Western Michigan College
Kalamazoo, Mich.

A Flow Spreader for every Condition





There is a patented Goldsmith-type Flow Spreader manufactured by Puseyjones for the most diverse paper machine conditions.

Flow Spreaders are in successful operation on Fourdrinier and on Cylinder machines ranging in width from 49" to 234" with flow quantities as widely different as 500 g.p.m. and 35,000 g.p.m. They are designed to permit ideal formation of paper and board of widely different sheet weights and over a wide range of machine speeds.

Even distribution of flow and uniform consistency across the machine are accomplished by a gentle "squeezing action" resulting from a moderate angle of spread and a progressive and even reduction of area during spreading.

Let us give you full details on the Puseyjones Flow Spreader as it applies to your forming conditions. Write or call us today.

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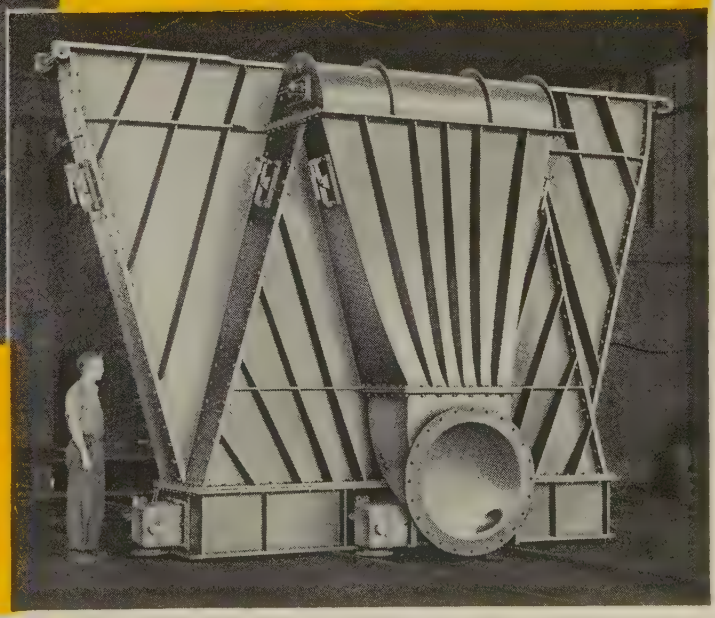
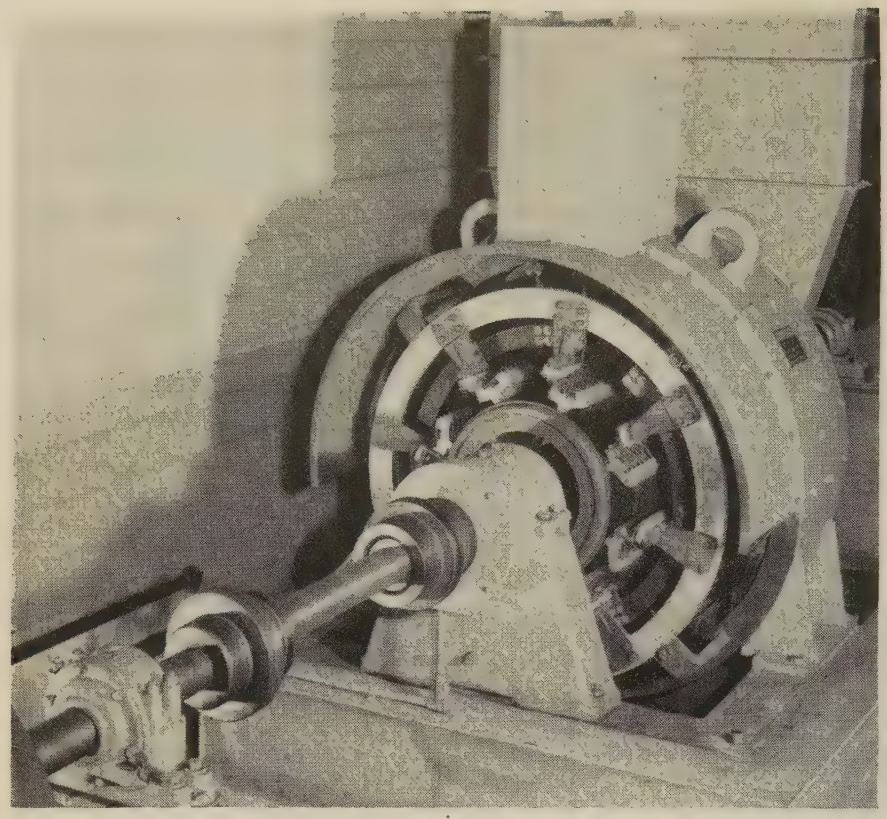
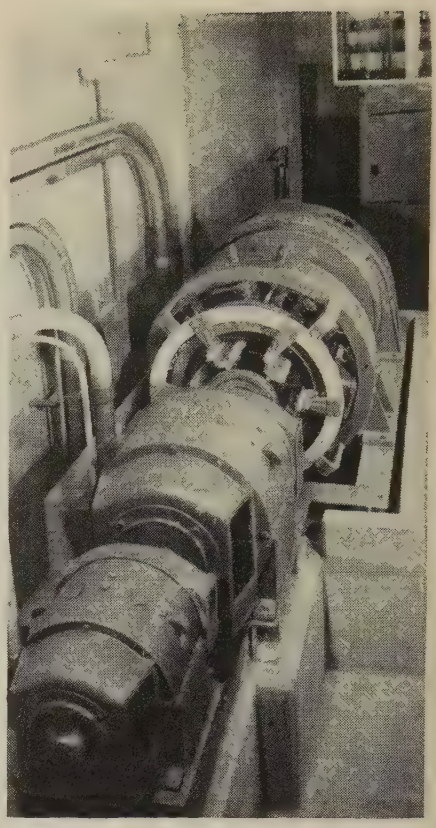


Top, a single-pass Puseyjones Flow Spreader for narrow and medium width machines.
Center, a three-pass Puseyjones Flow Spreader for medium width machines.
Right, a three-pass Puseyjones Flow Spreader for wide machines.

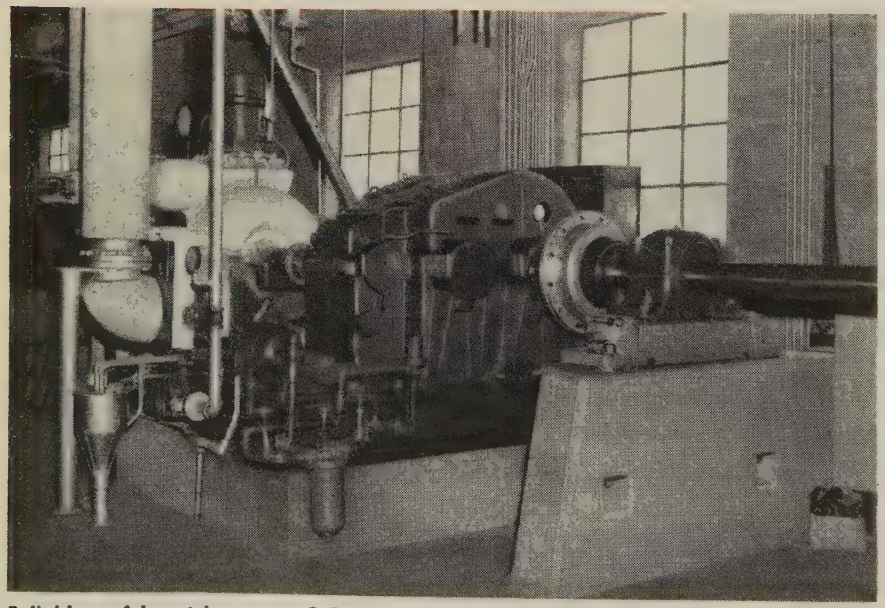


Regardless of load changes, any pre-set speed can be kept with pinpoint accuracy by G-E single-motor drives for lineshaft-driven machines. Simple, flexible operation—with speed ranges up to 10:1 or higher—helps maintain uniform weight and quality of the sheet. At the Camas, Wash., paper mill of the Crown-Zellerbach Corp., this G-E main drive motor for the No. 15 paper machine is rated 900 hp, 600 rpm, 600 volts.



Supplying power to motor at left is this G-E main motor-generator set, including 750-kw d-c generator, 1250-hp synchronous motor, 150-kw auxiliary generator, and 25-kw d-c exciter. All are mounted on a common base for easy installation.

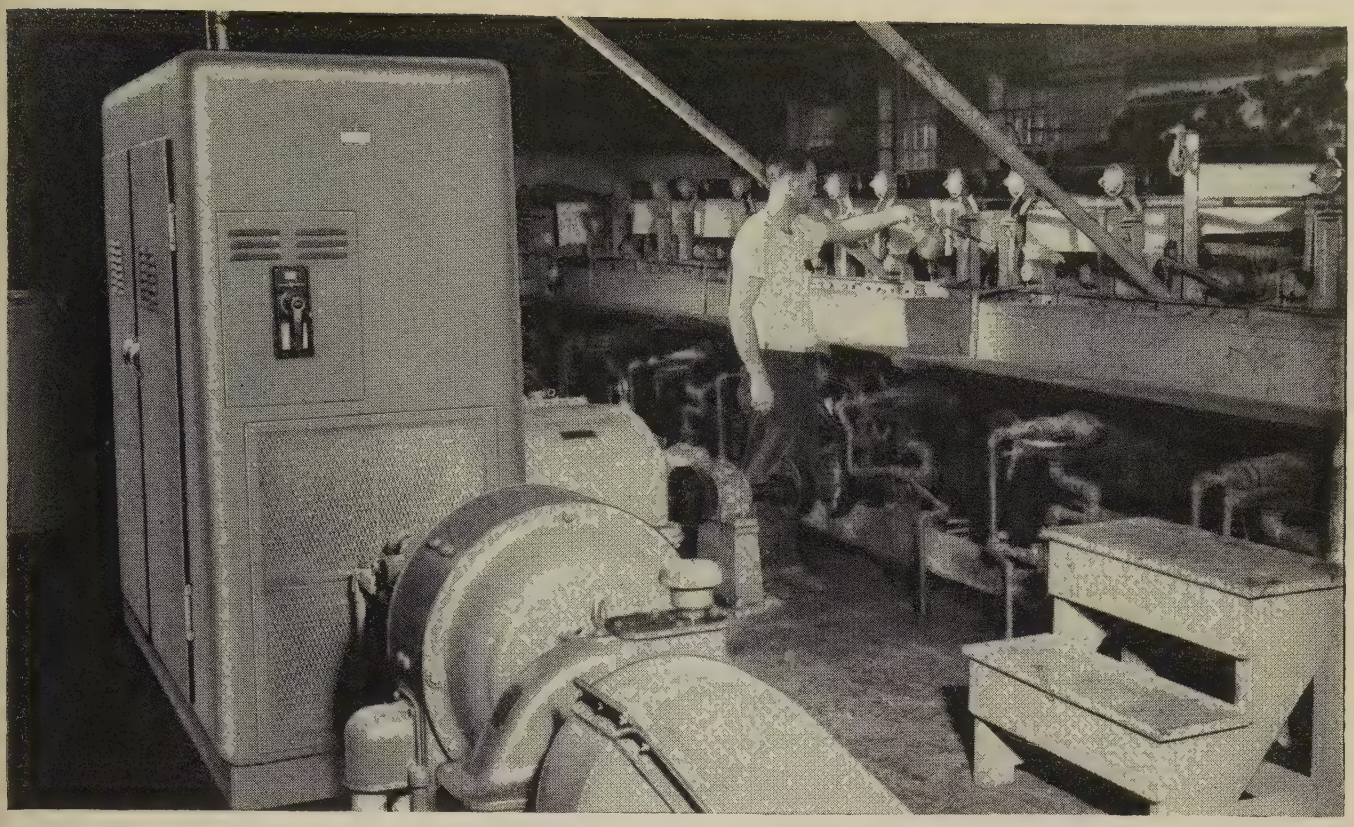
Get more paper from your



Reliably, safely, at low cost—G-E mechanical drive-turbines can provide your lineshaft machine with mechanical power as a by-product of your process steam. Adjustable speed with ranges up to 10:1 or higher are provided with great accuracy by their governors. At the Lewiston, Idaho, paper mill of Potlatch Forests, Inc., one of these G-E units—rated 1750 hp, 7000/450 rpm—is shown driving a paper-machine lineshaft.

CO-ORDINATED PAPER-MILL DRIVES

NEW! G-E Motor Selection and Application Course—timed to meet today's needs—can help train your paper-mill employees, increase their efficiency. A G-E "More Power to America" program, it shows how motors work, types now in use, how to select and apply them for specific jobs. Bulletin GEA-4938-16 describes the course in full. *Write for it!*



For smaller horsepower drives, easy low-cost installation is one big reason why more and more paper-mill operators are using the G-E Speed Variator single-motor drive. An adjustable-voltage d-c drive operating from a-c power, it includes a packaged power unit that's easy to install, maintain, and re-locate if necessary. At the Bay State paper mill of Crane & Company, Inc., Dalton, Mass., the compact, enclosed Speed Variator power unit—shown here behind its G-E 40-hp d-c motor on a lineshaft-driven paper-making machine—"makes for smoother operation all the way through," say company engineers.

lineshaft-driven machines!

One of these General Electric drives—correctly engineered to your needs—can bring out the best in your lineshaft-driven machines, increase your output of uniform-quality paper!

Which drive will do the most for *your* lineshaft-driven paper machines—in raising output to your paper machine's top capacity, maintaining a uniform high-quality sheet, and keeping your paper-making costs down?

It's a problem that can't be solved the same way every time. That's why General Electric offers paper-mill operators a choice of lineshaft drives shown on these pages. With this variety—and with an experienced G-E paper-industry engineering specialist helping in your selection and application problems every step of the way—you're sure of an answer that's *right for you.*

It may call for holding desired speed with great accuracy, either with a G-E single-motor drive or with an efficient G-E mechanical drive turbine to generate mechanical power and supply process steam. In either case, you'll get the right combination of speed-control and sensitivity, the speed range desired, and a drive that's easier to operate, provides top reliability, and requires less maintenance.

To get more paper from your lineshaft-driven machines, get in touch with your G-E paper-mill specialist—now!—at your nearest G-E office. Meanwhile, send for these bulletins: GEA-5288—"Single-Motor Drives," GEA-5580—"New Multi-stage Turbine Drives," GEA-4955A—"Type DP Turbines." *General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

655-10

PULP, PAPER, AND BOARD: 1951

(*Preliminary Report*)

Paper and board production totaled 26,086,115 tons and wood pulp production amounted to 16,494,386 tons in 1951, according to a preliminary report issued by the Bureau of the Census, Department of Commerce. These figures represent further increases from the high 1950 output of 24,377,222 tons of paper and board and 14,807,575 tons of wood pulp. (See below for detailed statistics.)

Paper production totaled 11,621,640 tons, almost 1 million tons greater than the all-time record 1950 figure. Production showed increases in all major grades except absorbent paper which showed a slight decrease from 1950.

Paperboard output in 1951 amounted to 11,604,536 tons, 6% more than that reported for 1950. The greatest gains were in liners and corrugating material. Construction paper and board production amounted to 2,715,508 tons, a slight increase over the 2,644,201 tons produced in 1950.

Wood pulp production increased about 11% to 16,494,386 tons. The greatest gains were indicated in the following grades: special alpha and dissolving grades, 29%; bleached sulphate, 33%; unbleached sulphate, 12%; groundwood, 12%; and semichemical, 23%.

The consumption of wood pulp and fibrous materials other than wood pulp in the manufacture of paper and board amounted to 17,703,944 tons and 10,522,724 tons, an increase of about 7 and 12%, respectively. The pulp mills consumed 26,575,934 cords of pulpwood measured on a roughwood basis, an increase of 12% over 1950. The consumption of hardwood species of pulpwood increased by 16%.

The preliminary 1951 data are the result of a summation of the monthly reports on Form M14A, "Domestic Pulp and Paper Monthly Report." The statistics represent a complete coverage of the operations of all known wood pulp, paper, and board mills. Final and more detailed data will be published in a summary report at a later date.

Starting in February, 1951, the regular Bureau of the

Table I. United States Production of Wood Pulp and Consumption of Wood Pulp, Pulpwood and Other Fibrous Materials in the Manufacture of Paper and Board, by Kinds, 1951, 1950, and 1949.

(Tons of 2000 Pounds)

Item	Production			Consumption		
	1951 Preliminary	*1950*[a]	*1949*[a]	*1951 Preliminary*	*1950*[a]	*1949*[a]
Wood Pulp, Total	16,494,386	14,807,575	12,171,786	17,703,944[b]	16,469,981	13,606,387
Special alpha and dissolving grades	616,802	478,849	374,050	51,315[b]	39,846	25,687
Bleached sulphite	1,761,890	1,628,692	1,454,971	2,038,411	2,029,399	1,824,559
Unbleached sulphite	754,916	740,895	707,263	1,203,011	1,246,876	1,161,416
Bleached sulphate	1,879,181	1,417,861	1,118,282	2,354,051	1,844,449	1,484,489
Semibleached sulphate	314,890	375,001	263,637	351,259	404,520	277,449
Unbleached sulphate	6,382,227	5,708,567	4,595,362	6,592,614	6,129,791	4,915,826
Soda	446,483	522,221	492,194	493,176	563,659	525,877
Groundwood	2,476,635	2,215,883	1,960,496	2,753,084	2,482,732	2,184,409
Semichemical	743,558	606,516	442,977	742,234	606,071	444,932
Defibrated or exploded	968,660	972,680	631,766	966,072	969,958	630,035
Screenings, damaged, etc.	149,144	140,410	130,788	158,717	152,680	131,708
Other Fibrous Materials, Total	...	...	...	10,522,724	9,395,374	7,814,695
Waste paper	...	...	...	9,078,879	7,956,036	6,599,606
Straw	...	...	...	401,397	405,618	385,890
Rags	...	...	...	389,434	441,894	381,915
Cotton fiber	...	...	...	41,036	21,286	22,710
Manila stock	...	...	...	22,549	39,883	26,809
All other	...	...	...	589,429	530,657	397,765
Pulpwood, Total (Cords of 128 Cu. Ft.—Roughwood Basis)	...	...	...	26,575,934	23,627,217	19,945,440
Softwood	...	...	...	22,823,445	20,405,910	17,330,495
Hardwood	...	...	...	3,752,489	3,221,307	2,614,945

[a] Revised.

[b] Wood pulp consumption reported by plants classified outside paper and board industries amounted to 713,840 tons, of which alpha and dissolving grades amounted to 671,974 tons. Comparable data are not available for the years 1950 and 1949.

Source: Data represent a summation of the monthly Facts for Industry reports (Series M14A) for the industry, revised to include late and corrected reports received subsequent to the publication of the monthly releases.

Bureau of the Census, Department of Commerce. These figures represent further increases from the high 1950 output of 24,377,222 tons of paper and board and 14,807,575 tons of wood pulp. (See below for detailed statistics.)

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The consumption of wood pulp and fibrous materials other than wood pulp in the manufacture of paper and board amounted to 17,703,944 tons and 10,522,724 tons, an increase of about 7 and 12%, respectively. The pulp mills consumed 26,575,934 cords of pulpwood measured on a roughwood basis, an increase of 12% over 1950. The consumption of hardwood species of pulpwood increased by 16%.

This report was prepared by Bureau of the Census, Industry Division, Wood Products Section.

Table II. Paper and Board Production in the United States: 1951, 1950, and 1949

(Tons of 2000 Pounds)

Item	*1951 Preliminary*	*1950*	*1949*
All Types, Total	26,086,115	24,377,222	20,315,436
Paper, Total	11,621,640	10,641,559	9,197,520
Newsprint	1,106,086	1,013,346	917,778
Groundwood paper	788,713	704,064	674,542
Printing and converting paper	1,115,204	1,020,002	887,371
Book paper	1,621,620	1,578,795	1,416,309
Fine paper	1,364,029	1,198,574	1,014,954
Coarse paper (including shipping sack)	3,597,144	3,285,635	2,757,731
Special Industrial paper	419,036	340,903	247,893
Sanitary paper	1,215,258	1,148,351	1,008,162
Tissue paper	270,138	225,199	186,667
Absorbent paper	124,412	126,690	86,113
Paperboard, Total	11,604,536	10,925,225	8,996,777
Liners	4,204,580	3,872,051	3,131,627
Corrugating material	1,814,508	1,636,881	1,305,890

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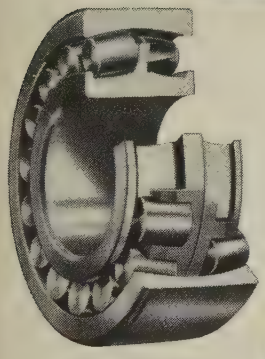

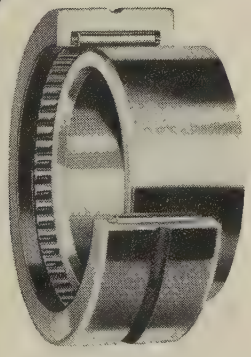

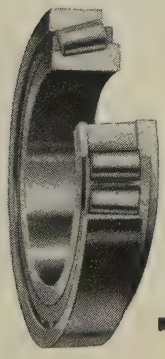

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Table II (*Continued*)

Item	*1951 Preliminary*	*1950*	*1949*
PAPERBOARD, TOTAL			
Container chip and filler board	327,878	321,345	242,559
Folding boxboard	2,428,794	2,368,848	1,942,871
Other bending board	853,097[a]	760,598	669,951
Setup boxboard	700,762	712,632	617,249
Other nonbending board	113,744[a]	164,551	130,792
Special paperboard stock	882,657[a]	1,001,571	872,634
Cardboard	79,494	86,748	83,204
WET MACHINE BOARD	144,431	166,237	131,036
CONSTRUCTION PAPER AND BOARD, TOTAL	2,715,508	2,644,201	1,990,103
Building paper and insulation	1,400,658	1,424,633	1,151,374
Hardboard and insulating board	1,314,850	1,219,568	838,729

[a] The figures shown for "Other bending board," "Other nonbending board," and "Special paper board" do not include production during January, 1951. The total for these grades for January is 199,022 tons. This quantity is included in the "Paperboard" total.

Source: Data for 1951 represent a summation of the monthly Facts for Industry releases (Series M14A), revised to include late and corrected reports. Data for 1950 and 1949 are from Facts for Industry Series M14F-00, "Paper and Board Production: 1950."

Census current statistical program for pulp and paper was modified to provide for additional statistical requirements of the National Production Authority. Accordingly, the present survey is conducted in cooperation with the National Production Authority under the authority of Public Law 671, 80th Congress, and the Defense Production Act of 1950, as Amended.

What's corn doing "deep in the heart of Texas"?

Research discovered that drilling for oil could be expedited by the use of a binding agent made of a product of corn. This firmed up the side walls . . . also aided in the early flow of sludge. "Black gold" speeded by yellow corn! This is but one of the numerous examples of how continuous basic research in corn helps American industry . . . helps you.

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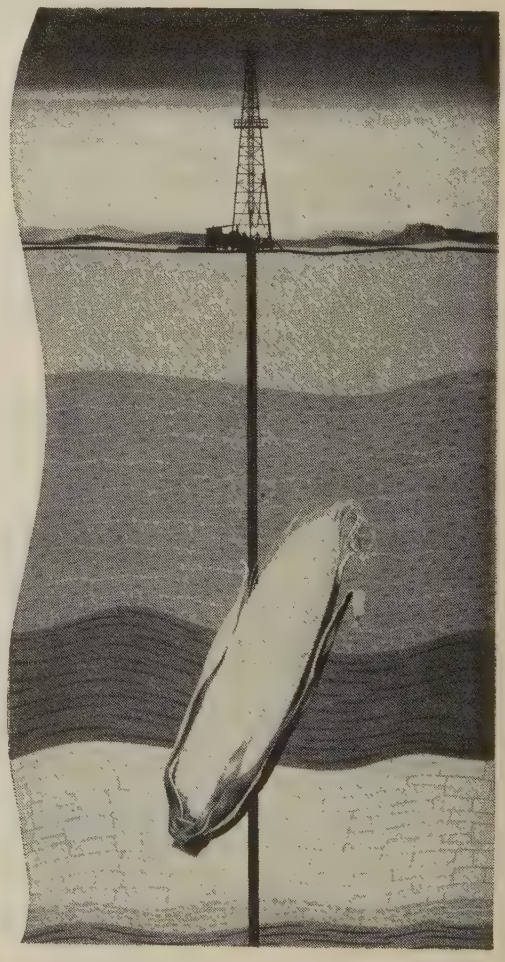
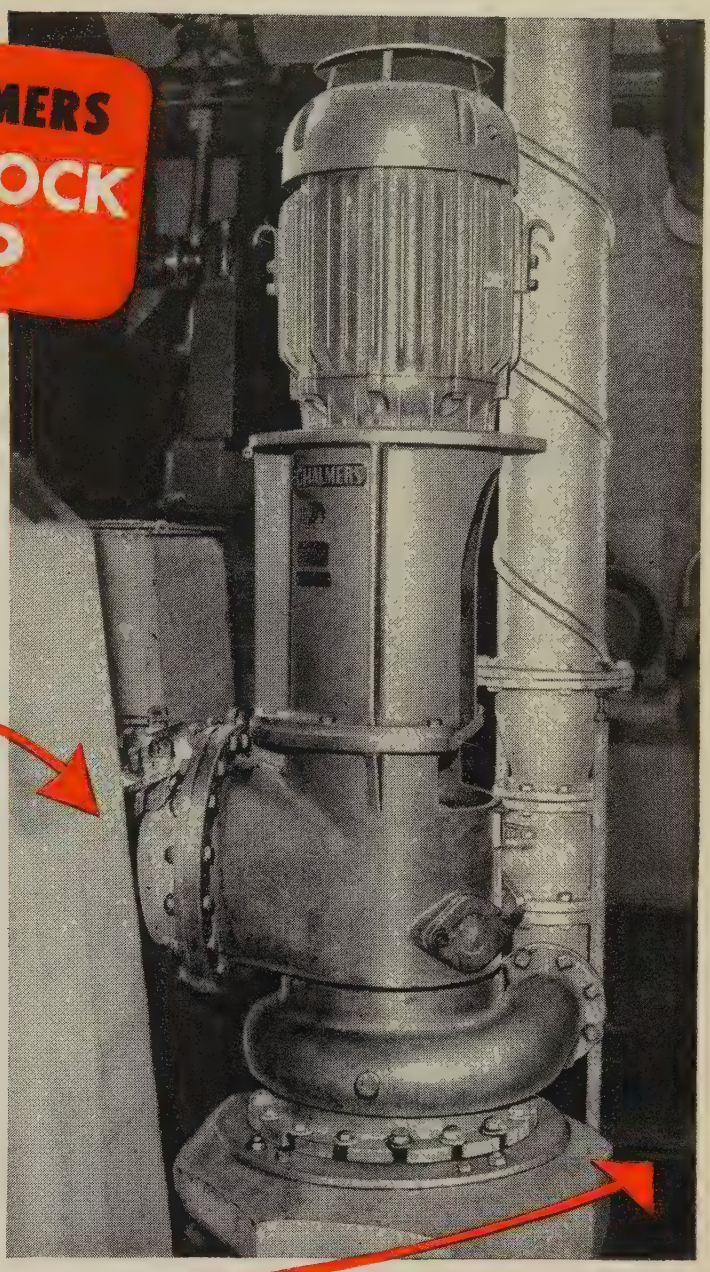


New ALLIS-CHALMERS PAPER STOCK PUMP

Vertical Design-

Saves Floor Space!



FLOOR SPACE COSTS MONEY and you can save a substantial amount by using the new Allis-Chalmers Vertical Paper Stock Pump. In new installations, it may be possible to tuck the pump away in a corner and thus utilize otherwise empty space. In modernization programs, a vertical pump may be the only method of fitting new equipment into existing space.

The basic pump design is the same as the reliable and performance-proved Type PW horizontal design. Notice the extremely large inlet which is standard regardless of pump size. Designed to handle up to 8% stock (when used with *Hi-Density* Feeder) and available in many materials, the Allis-Chalmers Vertical Paper Stock Pump is well suited to almost every paper mill operation. It will efficiently handle all types of acid and alkaline liquors as well as all types of high consistence stock.

COMPLETE PUMPING UNIT

Allis-Chalmers can supply the complete pumping unit — pump, motor and control — all of one coordinated design and manufacture. You don't have to worry about matching components and divided responsibility. And Allis-Chalmers pump application engineers are familiar with all phases of paper mill operation. They know your problems and can help you solve them. Get complete information on the new Allis-Chalmers Vertical Paper Stock Pump and what it can do for you. Call your nearby Allis-Chalmers District Office or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-3567

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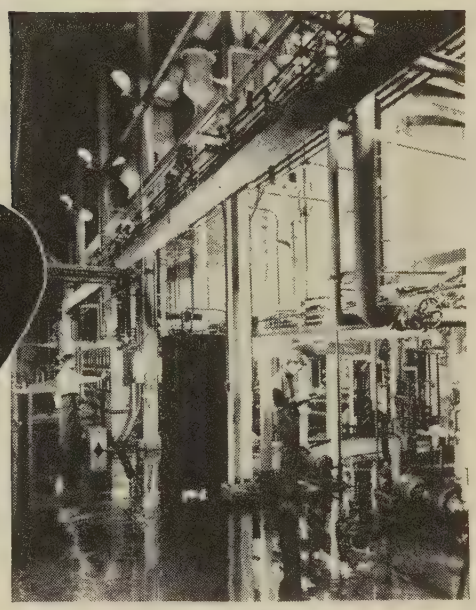
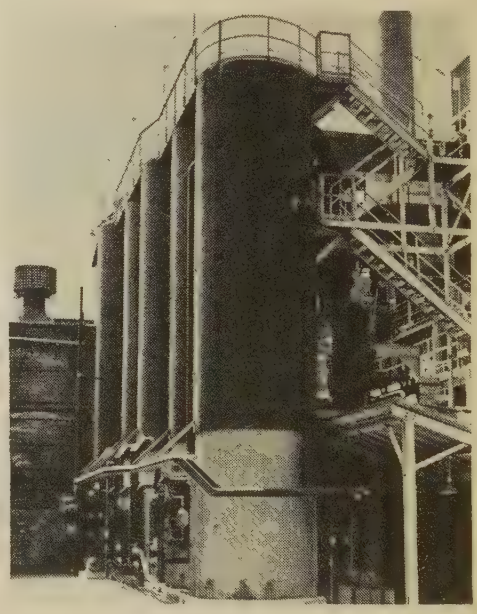


Designed to do your job best!



With minor design changes the Conkey Integral Evaporator is adaptable to any plant location requirement without sacrifice of its improved design and operational features. The Conkey may be set outdoors and provided with skirts making it completely self supporting. It may also be set indoors with the skirts omitted and structural steel supports added, which are provided either by the building framing or independent columns.

These advantages are found in all Conkey Integral Evaporators regardless of final job details: (1) Easier to erect. (2) Needs less space. (3) Lower overall pressure drops. (4) Larger, more efficient entrainnent separators. (5) Fewer mechanical joints to guard against air leakage.

Because its design reduces pressure drop losses between effects, the Conkey Integral Evaporator provides an increased working temperature drop across the heating element surface. Result: a net positive gain in evaporation—extra evaporating capacity. For complete technical information, write for Evaporator Bulletin.

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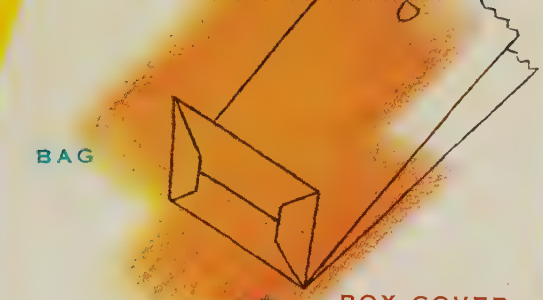

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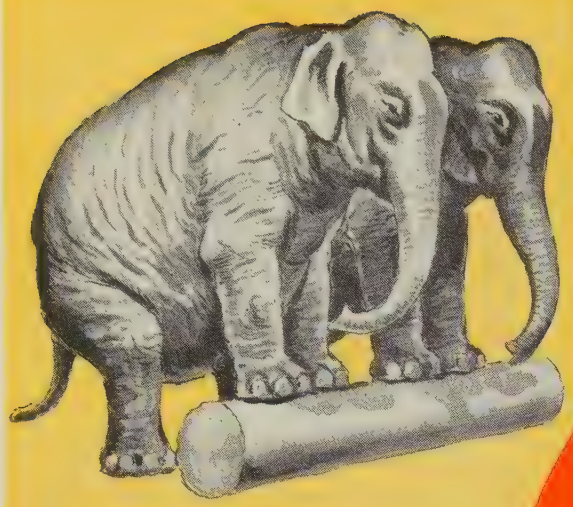

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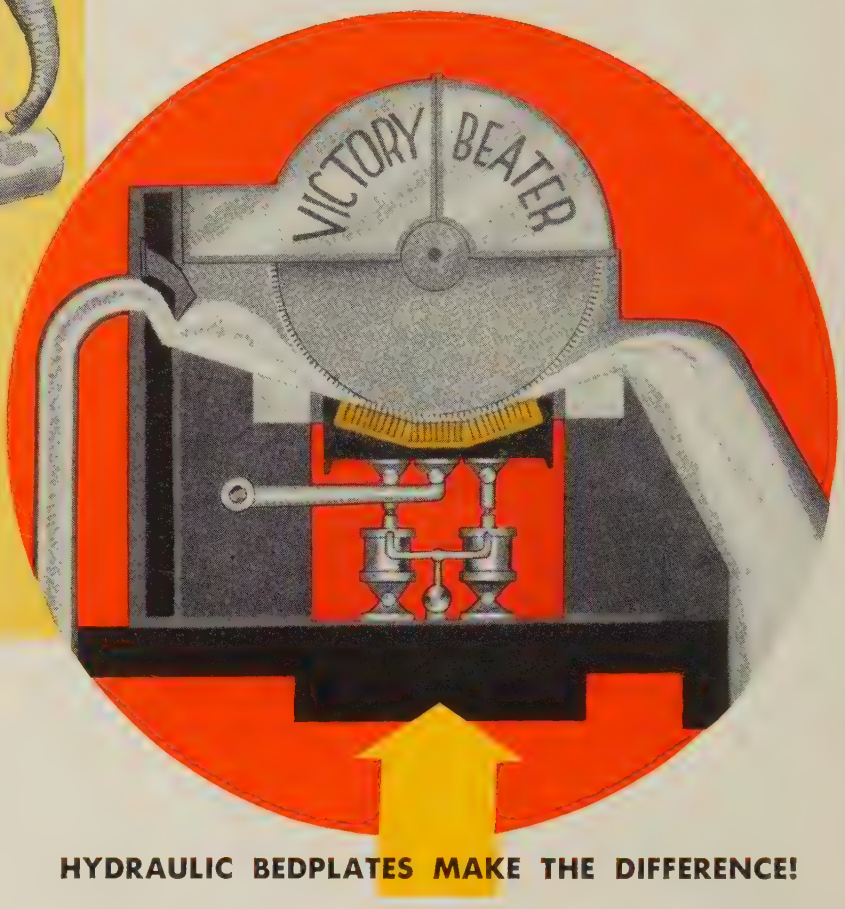

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Walter J. Murphy

SCIENTIFIC AND TECHNICAL MANPOWER PROBLEMS

WALTER J. MURPHY

When your secretary asked me several months ago to address the members and guests of the Technical Association of the Pulp and Paper Industry, I was very happy to accept. The reason I was so eager, is that I can now thank personally the men and women of the pulp and paper industry for the part they play in making possible the wide dissemination of scientific information.

Such knowledge usually is first revealed by word of mouth at meetings of scientific and technical societies, but progress would indeed be unbelievably slow were it not for the printed word. The world of science and technology as we know it today, has occurred because thousands could read, whereas only a comparatively few could hear the reports of the world's great and not so great, but nevertheless, important scientists. As an editor of several scientific and technical journals, I voice my appreciation and the appreciation of chemists and chemical engineers generally for the quality paper one finds in our publications.

When Mr. Macdonald first wrote me, he suggested I talk at one of your technical sessions on chemicals in short supply. He said he was very much impressed with an analysis of the sulphur shortage that had appeared in *Chemical and Engineering News*. I confessed immediately that I was not the author of the article. It was written by Howard Sanders, a young assistant editor, and I suggested that Sanders or Harry Stenerson, our veteran market editor, could discuss chemical shortages more authoritatively.

Before we came to any final conclusion, Mr. Macdonald suggested that I be the speaker at the Association luncheon. The proposal appealed to me for two reasons—it permitted me to go through with my plans for a winter cruise, but more importantly, it permits me to discuss with this very influential group a shortage that is far more serious than the present shortages in certain chemicals. I refer to scientific and technical manpower. We can correct almost any shortage of a chemical or other raw material if we have adequate scientific and technical manpower. We cannot solve scientific and technical man-power shortages in a test tube or in a chemical plant.

Walter J. Murphy, Editor, *Industrial and Engineering Chemistry*, Washington, D. C.

First, let me define what I mean by scientific and technical manpower. I refer to scientists capable of initiating, conducting, and directing original research of either a fundamental or applied nature; I refer to engineers and technologists capable of initiating and directing mass production. Very definitely I do not refer to technicians, subprofessionals, and those who essentially are engaged in a work of a routine nature. Let me say a diploma or even several are of little importance or significance if the owner is not truly performing work of a professional character. There is no critical shortage of technicians—there is a desperate shortage of scientists and technologists. Should a shortage of technicians occur, it can be corrected rather quickly. But it takes from six to ten years to train scientists and top-flight technologists.

The present lack of adequate numbers of scientists and technologists can be traced to the short-sighted policies of Selective Service during World War II. We failed to keep the supply lines in our colleges and universities filled. We did what we did in the name of democracy, but it was a terrible blunder that may yet be the chief cause of losing every semblance of democracy in the future. The United States was the only major power that followed such a suicidal policy.

World War II demonstrated that superiority in science and technology is absolutely essential to victory. Some of our top political and military leaders sensed this revolutionary change in warfare. Most politicians and much of our military brass still close their eyes to the absolute essentiality of leadership in science and technology in modern warfare, the politicians because they are afraid to sponsor what they think will be Selective Service laws of such a nature as to be extremely unpopular with the voters, the brass because they hate to acknowledge that military superiority today is largely superiority in science and technology. Fortunately, the traditional "spit and polish" type is moving out of our armed services.

I dare say many in this audience have at least heard of "Science—the Endless Frontier," written by Vannevar Bush as a report to President Roosevelt in 1945. The Bush Report led to an even more extensive study of the modern role of science and technology in war and peace popularly referred to as the Steelman Report. I am sure some of you have read at least the most significant portions of this report to President Truman. In both reports we find warnings of impending shortages of scientists and technologists.

These warnings and the experiences of World War I and World War II resulted in a somewhat more intel-

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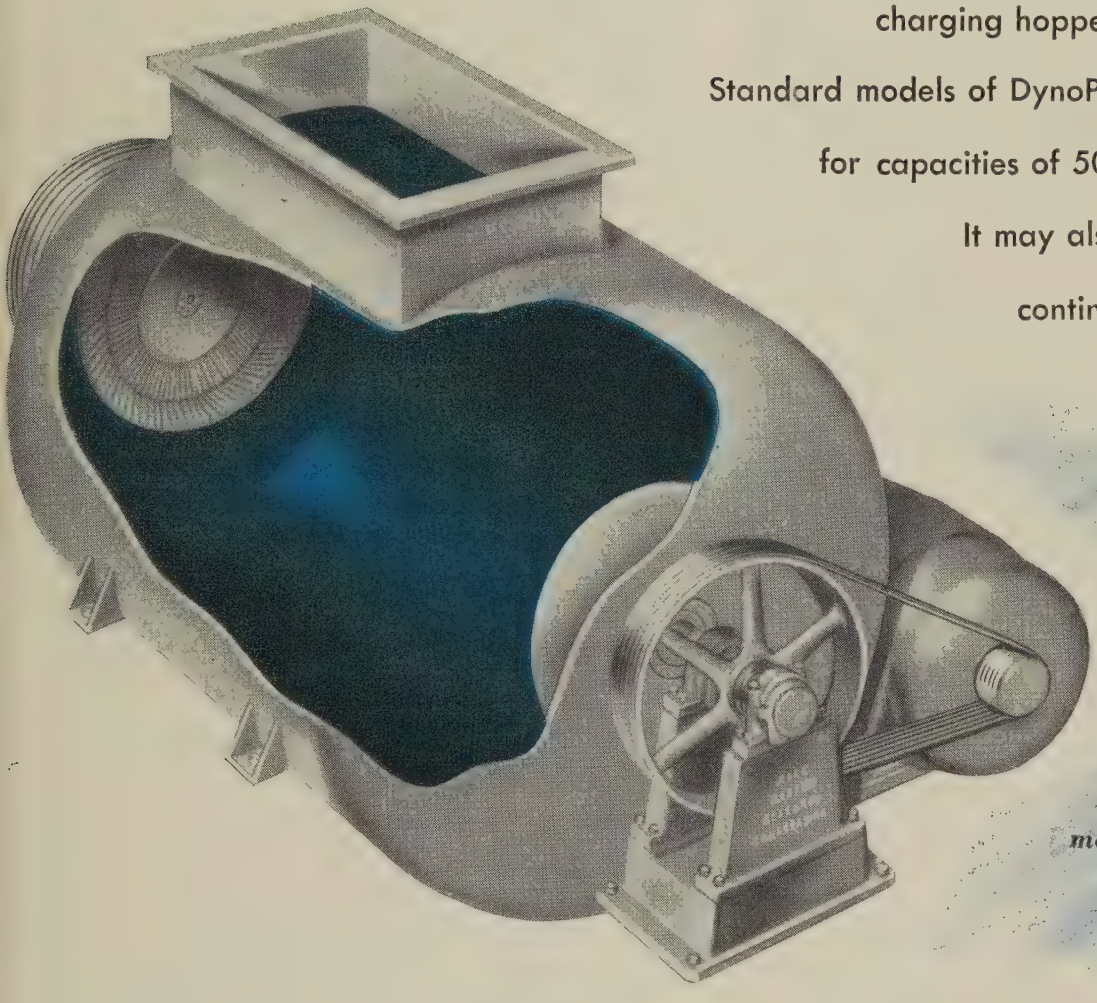

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ligent approach to the scientific and technical manpower problem with the outbreak of hostilities in Korea. Nevertheless, the situation is still full of dangers which I will try to point out to you this afternoon.

Neither the Bush Report nor the Steelman Report envisioned a Korea in June of 1949, although the latter frankly did recognize that the continuance of a free world was dependent upon United States leadership in science and technology.

Some Statistics

A post-luncheon talk is an inappropriate time to present a mass of documentary statistical evidence. I will spare you as much as possible. It is generally agreed there is a shortage of competent scientists and technologists. Quite naturally the individual who has had a training in science or technology and cannot obtain a job, or is not occupying a post that he thinks is commensurate with his training and experience, or is not being paid what he thinks he is worth, will dispute the statement of the existence of a shortage. Many a scientist or technologist finds it difficult to get a satisfactory job or fails to advance, not because of incompetence in science or technology, but because of personal characteristics that rarely, if ever, are recognized by the individual who is cursed with an inability to get along with people and is incapable of leadership.

Then there are those who despite formal training in science or technology are not creative, and there are those who fail to keep informed of advances in this particular field and drift into routine jobs. To all such individuals there is no such thing as a personnel shortage. But there is one and it will become worse over the next few years.

Let us look at the figures on engineers. In 1950 some 50,000 were graduated—a peak due to the large number of veterans taking advantage of the educational provisions in the G.I. Bill of Rights. Prior to the outbreak in Korea, it was estimated that at least 30,000 to 40,000 engineering graduates a year would be needed to keep the pipe lines filled. Now we discover that for the next four years there will be a steady decline in the number of graduates and that along about 1954, the number will be somewhere between 12,000 and 17,000. And, of course, a relatively high percentage of those graduated will be taken by the armed forces.

While statistics on scientists are not as readily available as they are for engineers, it is very evident the supply of individuals with Ph.D. training is declining and the number will continue to decline at least through 1960.

Relatively few people in this country realize the extent of the demand that government is now making on our meager supply of scientists and technologists. The number of qualified technical personnel now required for the Department of Defense research program amounts to 43% of the entire national supply! It is expected that sometime in 1952 the figure will increase to 52%. If the requirements of the Atomic Energy Commission and other agencies engaged in defense research are included, the number reaches the staggering total of 65% of all available manpower equipped to do scientific research. The speed-up in atomic research unquestionable will raise this total still higher. It is obvious, therefore, the pool of scientists and technologists that will be available to industry will be drastically reduced in the near future.

Perhaps some of you read the recent newspaper account of an interview with Gordon Dean, chairman of the Atomic Energy Commission, in which he stated that the AEC program will need at least 5000 more scientists and technologists. Mr. Dean realizes how difficult it will be to get such numbers, but he said grimly, "We will get them." Need I tell you he is to get them largely from industry?

The shortage of chemists and chemical engineers would be bad even though the chemical and process industries were static—which they are not. It is a desperately critical condition, when we total up expenditures in 1952 of several billions of dollars for increased production facilities. And this is not the entire picture for huge expenditures for new plants in 1953 and 1954 are contemplated by industry. I wonder where the technically trained manpower will come to operate all these new facilities?

General Hershey, head of Selective Service, had been damned again and again as the person responsible for the continued shortage of scientific and technical manpower. I have done my share of damning him during World War II—perhaps more than my share. There is no question but what the short-sighted policies of Selective Service during the late war have been a strong contributing factor to the present shortage. But very definitely we cannot put all the blame on Selective Service for the shortages we will face over the next decade. Generally speaking, industry has not recognized the truth of this statement—but it better do so at once or suffer some very grave consequences.

Reasons for the Shortage

The plain truth is that too few of our youth are being attracted to science and technology. Why?

There are several reasons. In the first place the birth rate in this country dropped considerably during the Depression of the Thirties. In the second place, a report of the U. S. Department of Labor, issued in March 1949 (Labor Statistics Bulletin 968), indicated a strong likelihood there would be a surplus of scientists and engineers as a result of the large number of G.I.'s in such courses. This assumption was based on the prewar trend in employment of scientists and technologists. Naturally vocational guidance counselors urged high school youngsters to avoid these professions. Again in 1950, a chart of the Department of Labor given wide circulation created for the second time a very false impression. While recognizing this time the increasing need of engineers in industry, it concluded: "so many will be graduated in the next few years many graduates will be unable to get engineering jobs." The Department of Labor revised the chart and prognostication when the accuracy of the figures was challenged, but many a youngster was turned away from science and engineering as a result of these unfortunate bulletins.

There are, however, other very important reasons why many a youth turns away from training in the sciences and technology. These are the factors I want to discuss today.

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very, very uncertain for the young man who knows that sometime between 18 and 26 he will have to serve two or more years in the armed forces even if the so-called Cold War does not spread beyond Korea. He knows that if a World War III erupts, he most certainly will serve several years in the armed forces and that his education will be interrupted.

Under these circumstances, can you blame a young man of 18 if he says, "To hell with a college education, I'll get a job that will pay me enough to get married."

He knows that to be a scientist he must study for seven to ten years. He suspects that his Ph.D. is only a license to practice his profession, not a guarantee of a successful career. He knows it is getting more and more expensive to get a training in science and technology, and probably someone has told him that if he does become a scientist or technologist, the chances are he will not earn as much as a bricklayer. Gentlemen, youths who are so imbued with a desire to be another Priestley that they care nothing about financial remuneration, are relatively few in numbers in this modern age.

Most scientists and technologists who are at all competent are making more than the average annual income of bricklayers. But you might just as well face the fact that the take-home pay of the laborer, skilled or unskilled, in your employ has increased percentage-wise to a much greater extent than the income of the professional in your laboratory or in your plant. Your professional employees are not wholly oblivious to this fact. You probably would be quite surprised to hear vocational guidance counselors telling high school students that a career in science or technology is not very remunerative. You know, and I know, a great many technically trained who are doing well financially—but frankly, most of these are paid well because of executive or managerial ability. Admittedly, it is very difficult in most instances to judge quantitatively the real contribution of a scientist or an engineer. Certainly it is not as easy as it is to judge the performance of a salesman. Research today is largely a team proposition, but somehow management in many instances must learn how to evaluate better the services performed by scientists and technologists and to pay accordingly. Industry no longer can afford to ignore the inequality that exists between the financial return of the professional employee when compared to the non-professional.

Indeed, the law of supply and demand is beginning to operate in favor of the scientist and the technologist. The young Ph.D. chemist, fresh out of school, for example, received $6000 in 1951. That figure will be higher for the 1952 crop. The Ph.D. out five to ten years is aware that relatively speaking, he is not doing as well as his associate who has just graduated and, in many instances, he starts shopping around for a new job. If he is any good, he doesn't have too much trouble, because jobs are plentiful. This is an inexcusable waste of scientific manpower when it is in such short supply, but can you honestly blame the professional?

Influence of Professional Societies

Many scientific and technical societies are concerned about the present and future shortage of scientists and technologists and are expanding their activities in vocational guidance.

Let me tell you, however, there are many members of such societies who are very critical of such programs saying in so many words, that professional societies have no business encouraging more of our youth to enter the professions because this will tend to depress salaries in the future. With critical shortages ahead, they see still higher salaries in the offing. They do not wish to see the law of supply and demand tampered with when it works to their advantage. Some of those who want their professional societies to cease and desist are the very ones who would demand that their professional societies institute minimum salaries in periods when there are more scientists than there are jobs for scientists to fill.

The professional society member who dislikes his organization messing with the law of supply and demand has much in favor of his position. I think there is one perfectly legitimate reason for the scientific and technical societies encouraging more of our youth to enter the sciences and it is that the very safety of this nation requires we maintain superiority in science and technology. We can never hope to match the Iron Curtain countries in manpower. Nor can we afford to lose sight of the fact that Russia is going all-out in science and technology. Do not be deluded by stories that Russian scientists are not free to judge for themselves what is and is not in accord with the true facts of science. This is true in certain scientific disciplines, but in those that really count in a military way, such as chemistry and physics, there is very little, if any, interference.

Russia did not draft scientists and technologists in World War II as we did, nor did she strip her schools of technology as we did. There is every reason to believe Russia is training more scientists and technologists than we are. If we continue on the path we are on, it is questionable that we can maintain superiority in science for much more than a decade.

I would remind the individual who is critical of societies in their efforts to recruit more prospects for science and technology of two other points. One, that vocational guidance work should be directed to discouraging the obviously misfits from entering the scientific processions, as well as encouraging the qualified to pursue careers in science. Two, that the very definition of a profession requires those who are members must serve humanity in a very vital way. Certainly those in the sciences have a great responsibility to help prevent the spread of totalitarianism in this world. The scientist and the technologist cannot brush aside this responsibility—and the vast majority do not wish to do so.

Comment to Executives

To the employer of professionals, let me add a word or two of warning. Admittedly it is a dangerous situation to have too few scientists and technologists. It is almost as dangerous to have too many—to the point where financial remuneration falls to a point where the youth of America no longer is interested. I urge you not to be short-sighted in this matter, but rather to look at it from a long-range point of view. Even from a strictly selfish viewpoint, you will be smart to see that

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your professional employees are well satisfied. You cannot turn research on and off like the spigot of a barrel and expect it to pay off. You cannot drop half the research force the minute sales and profits decline slightly and then expect your technical staff will be able to solve all your problems in the course of a week or a month.

You executives must not leave this man-power problem entirely in the hands of the scientific and technical societies. The responsibility is just as much yours as an employer as it is mine as a society executive. There are a number of positive actions that you must take if we are to continue to keep this country so strong that Soviet leaders will not dare to attack us.

You must participate in vocational work. Two companies that I am acquainted with, Diamond Alkali and General Aniline and Film, in their advertising copy discussed quite frankly the matter of salaries being paid chemists and engineers. You can in many ways build a better understanding of science by the lay public. In brief, be highly public relations conscious.

Possibly I have touched on a sore spot in mentioning public relations. I do not know what the pulp and paper industry is spending, but I do know the chemical industry has only just awakened to the need for building a better appreciation by the public of what the industry contributes to the health and wealth of this nation. Whereas the petroleum industry is spending this year nearly three million dollars on public relations, the chemical industry appropriated the insignificant sum of $22,000 for its public relations program. This figure was upped to nearly $200,000 when the industry found itself under serious attack on the question of chemicals in food. The American Chemical Society spent $80,000 in 1951 for public relations and will spend a like amount this year.

Selective Service

I intimated earlier that the administration of Selective Service is more intelligently done now than during World War II. It is true we are not denuding our colleges and universities of both students and instructors. I honestly believe the industry is trying to utilize the technical skills of the young scientists and technologists drafted but many are serving as hospital corpsmen, many are serving in the infantry, when all of them should either be used by the armed services in jobs that require special skills or should be returned to industry.

I greatly fear that if another World War were to break out tomorrow, we would duplicate on technical manpower all the horrible mistakes of World War II. If this does happen, God help us—we will be defeated. I saw Germany in defeat. I shudder to think what will happen to us if we are at the mercy of the Communists. They know no such word as mercy—ask the men and women of Berlin.

There is a basic flaw in the Selective Service Act and this weakness will never be corrected until the public demand it. To get the American public in such a frame of mind will require the greatest program of mass education this country has ever seen. You must participate actively in this program if it is to have even half a chance of success.

The basic weakness I refer to is the fact that the local draft board has the authority to draft the scientist and the technologist and the students pursuing careers in science and technology. No one can gainsay that this is pure democracy, but it is also just about the most effective way of guaranteeing victory for our enemies.

The military need should have scientists and technologists, but only to the point where the armed forces are using the special skills of these individuals. We do not draft doctors in order to put them in the Army, Navy, Air Force, or Marines as combatants. We must not waste our scientific talent either. And just to keep the record straight, let me say that no professional society asks for blanket deferments. The scientist or technologist to rate deferment should be performing essential professional services.

It was clearly shown in World War II that most draft boards do not have sufficient knowledge to judge wisely on the matter of deferments for scientists and technologists. That is why the Scientific Man-Power Advisory Committee of the National Security Resources Board, of which Charles A. Thomas was chairman, urged in its program that a national committee of scientists and technologists be given the power to handle deferment problems of scientists and technologists. Such men are better qualified to separate the wheat from the chaff. They will know who is really essential and who is trying for deferment simply because of the ownership of a degree in science or engineering.

Congress has refused to buy this recommendation of the Thomas Committee and will continue to ignore it as long as it appears to be politically expedient to do so.

Public Relations

Our program of education must be at the grass-roots. We must convince the lawyer, the doctor, the businessman, the teacher, the minister, the priest, the rabbi, and most important, we must educate Mr. and Mrs. Smith whose boy is about to be drafted that it is sound policy to defer the Jones's boy if he is a scientist or technologist.

We must somehow convince the Smiths that the only way their son has a chance of survival is to have superior weapons and more and better materiel of every kind required in modern warfare. Let me assure you, this is no easy task—but it is not an impossible one if all of us join in the program of education. Very definitely we will not succeed if most of us take a "Let George do it" attitude.

If I as a chemical engineer or as an editor of a technical society journal tell the public that our present Selective Service Law is, indeed, a potential danger to our survival in the event of World War III and needs to be revised so we do not dissipate our meager resources of technical man power, I am suspect. But if the minister, priest, and rabbi tell their respective congregations the same story they will be believed.

Unfortunately, when the subject of deferment is raised, reason goes out the window and passion takes its place. One can well understand why.

It is necessary for us to point out to the public that modern warfare is quite different from the type of mili-

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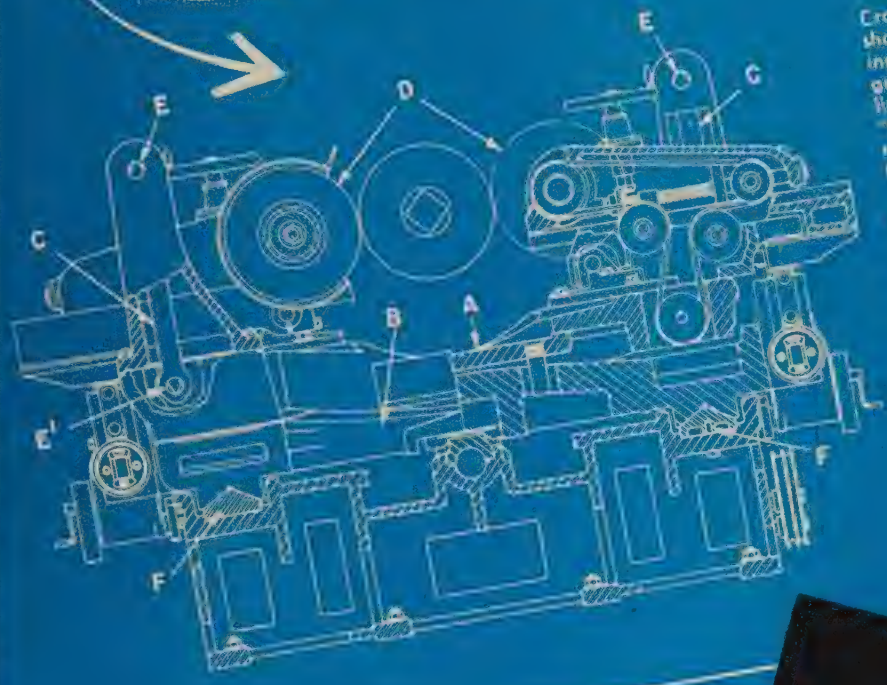

Cross section of bed and carriage showing swing-rest mounting of grinding wheels in a Farrel two-wheel roll grinder. The saddle "A" is swung by links "C" on knife edges "E" and "E'" from brackets supported on carriage "B". On this saddle are mounted the grinding wheels "D".

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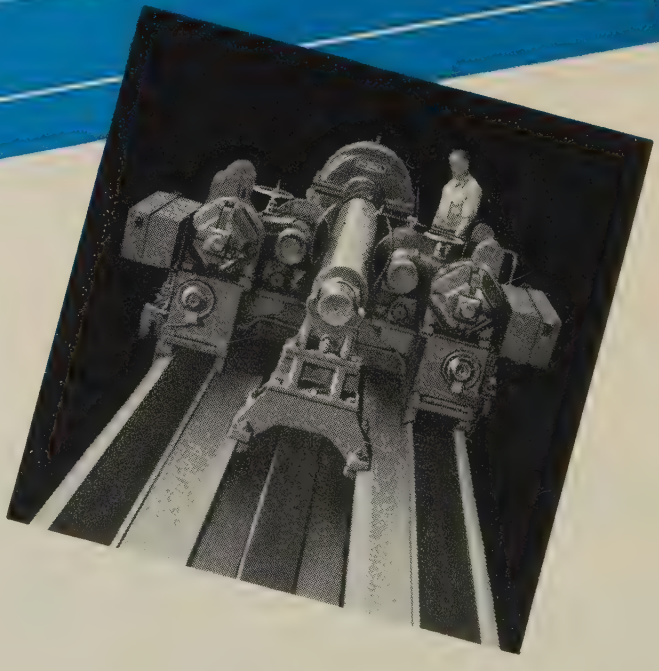

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tary activity that occurred during the Spanish-American War. Indeed, the discovery of the atom bomb, guided missiles, nerve and poison gases, the use of destructive bacteria as a possible weapon, all these have changed radically the relationship of the soldier and the civilian. It is important to point out the most potentially dangerous spot to be in if we have an all-out war is a highly industrialized city.

The public must be educated from its almost child-like belief that a uniform *per se* represents the difference between a hero and a slacker. It must understand that not every man in uniform serves in the front lines.

The public must be told that if we are to be consistently democratic, we should rotate men in uniform so that all take their turn in the foxhole. This may be totally democratic—it is not effective way to win a war and the armed forces does not follow such a practice.

The public must be told that the armed forces practices deferment—how else can you explain West Point, Annapolis, and all the forms of ROTC?

The public must be educated to the true meaning of the words "selective service." They should not mean that every one carries a rifle; they should mean that in total war each individual does the work he or she is best fitted to do in relation to the one object of winning the war.

Such a program of education of the American public cannot be successful if it is undertaken halfheartedly and haphazardly. No program more difficult of attainment has ever been undertaken. When you start to tell Mrs. Smith or Mr. Smith why their boy must be taken by the armed forces while their neighbor's son, the Jones's boy is deferred, you have to be mighty convincing and you must recognize that human nature being what it is, you better show the Smiths some pertinent personal reasons why their son must have the research and production that the Jones's boy and many other Joneses alone can provide.

Gentlemen, time is running out on this nation, yet we fail to sense the danger we face in not recognizing to provide adequate numbers of scientists and technologists for the future.

What will it avail us to build more and more research palaces; what will we profit by building new production capacity if we do not have the highly trained individuals needed to staff these facilities? Scientific and technical manpower is the most critical of all our shortages.

The scientific and technical societies are planning to bring this problem to the American public at the grass-roots level. But for this program of education to succeed it will need not only the active support of such organizations as this one, but it will need their active participation. They will need your help as an organization and even more importantly as individuals.

Last year I spoke before the Rotarians of Philadelphia. I told them that if we fail to educate scientists and technologists in sufficient numbers and if we do not use intelligently the inadequate numbers we have, they could expect the City of Philadelphia to lay in ruins in World War III. I told them, too, that I would not be there to tell them, "I told you so"—because Washington by then will be in ruins—and so will New York, Chicago, Pittsburgh, and Detroit.

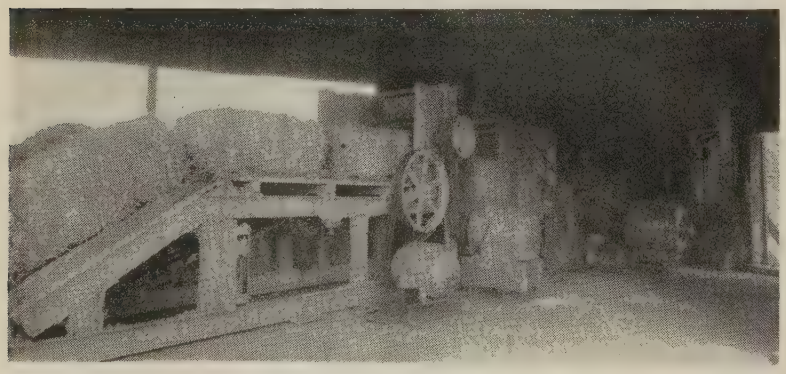
I do not like scare psychology, but sometimes it is the only approach that is effective and that brings action. I cannot see how the chemical and chemical process industries can function and expand over the next 10 to 20 years unless they can bank on well-trained highly skilled chemists and engineers. Yours cannot be a static industry and prosper. Research is the one sure road to continued success for any industry that uses nature's raw materials.

If you wish to remain free men, if you wish to bequeath to your children and your children's children a free world, then you must give this problem immediate attention and plenty of personal participation. The alternative is a slavery even more horrible than that devised by Hitler and the fiends who surrounded him.

I realize that many demands are made upon you for your time. Which one is more important than the cause I have pleaded this afternoon?

Unless we meet this problem immediately with foresight and a very remarkable degree of intelligence, world leadership will pass to the Soviets in two decades. It is a grim picture I have painted for you but one that is not exaggerated. Stalin and more particularly his younger associates are sitting in the Kremlin firmly convinced that scientific and technical manpower is the big mistake we will make that will sound the death knell of democracy for a thousand years.

Presented at the Annual Meeting of the Technical Association of the Pulp and Paper Industry, Commodore Hotel, New York, N. Y., Feb. 21, 1952.



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REPORTS AND DISCUSSIONS

Presented at National and Regional Conferences

Condensations of Annual Meeting Papers

THE following are condensations of a number of papers that were presented at the 37th annual meeting of the Technical Association (Feb. 18–21, 1952). Most of the papers will be published in full in subsequent issues of *Tappi*.

The Over-all Water Supply Situation Throughout the United States Pulp and Paper Regions, FRED H. KLAER, JR.

Many attempts have been made in recent years to appraise the water supply situation in the United States as a whole. It appears to be commonly agreed that the total supply of water on the earth has not changed appreciably during the history of man, that the majority of present-day water problems are due to the distribution of supply and demand both with respect to geographic location and to time, that water use has increased tremendously in the past few decades, and that additional water supplies are still available in parts of the United States. The demand for water as a cooling medium and for water of rigid chemical quality for specific industrial processes is increasing while the sources of water that can be developed easily and cheaply are becoming fully utilized. The cost of water will rise as the demands for additional supply become more pressing. Throughout the eight major pulp and paper regions of the United States, there are still undeveloped sources of water, but they may be expensive to develop and to operate to provide water of satisfactory chemical quality.

The future of water supplies for industry as a whole and for the pulp and paper industry which uses large quantities of water, will depend in large part on the ingenuity of the design engineer in utilizing the available water resources, both surface and underground, in the most efficient manner possible, in preventing unnecessary wastage of water, in reuse and recirculation of water wherever possible, and in using surface and ground-water reservoirs to store water during periods of surplus water supply for use during dry periods either by increasing natural recharge or by practicing artificial recharge. One means of utilizing the available sources of supply efficiently, in areas where the natural geologic conditions are suitable is developing ground-water supplies by induced infiltration from some surface source by Ranney horizontal collectors or by wells.

The Use of Asphalt Emulsions in the Manufacture of Insulating Board Products, J. J. PEROT

This article presents a brief history of emulsified asphalt sizes together with a brief description of the evolution of insulating board to its present status as a structural building material.

Techniques for the introduction of asphalt emulsion into insulating board stock are outlined and precautions necessary to insure maximum retention and efficiency are described. Data from experimental plant runs are presented to show the advantages of the use of asphalt emulsions in insulating boards.

A Preliminary Investigation of the Adaptability of the General Electric Puncture Tester to the Testing of Structural Insulating Board, J. A. VAN DEN AKKER, KEITH W. HARDACKER AND E. J. JONES

The General Electric Puncture Tester (GEPT) has been investigated as a possible means for testing the puncture resistance of insulation board. It has been provided with a special specimen holder which supports a specimen in a manner partially simulating the span involved in typical use of insulation board. In order that the testing of $^{25}/_{32}$-inch sheathing might be encompassed, the scope of the GEPT has been extended to a new "range 5." A detailed analysis of the energy effects in the puncture of insulation board by means of the GEPT equipped with the special specimen holder is presented. The energy expended by the device during a test is considered in two phases: Phase 1 involves flexing of the specimen to the point at which local rupture commences in the small region immediately above the puncture head, and phase 2 is comprised of the processes of disruption and puncture. Materials for the experimental work were $^1/_2$-inch building board, $^1/_2$-inch tile board, and $^{25}/_{32}$-inch sheathing, acquired on the open market and handled by code designation only. The mechanical behavior of the special specimen holder was satisfactory; it was found to be adequately rigid; its design was such that specimens were flexed and punctured without a single instance of failure by flexural breaking. Orientation of the machine direction of the board was found to be unimportant, and puncture data obtained with specimens firmly clamped along both the machine and cross-machine pairs of edges, and along only the machine or cross-machine pair of edges, show that it is immaterial whether only one pair of opposing edges or all four edges are firmly clamped. Puncture data obtained with the specimens lightly held against the specimen holder show that the effect of firm clamping (as compared with no clamping) is, if real, of the order of experimental uncertainty. In the testing of 40 specimens of $^{25}/_{32}$-inch sheathing made by different manufacturers it was observed that the GEPT, operating on the new range 5, successfully punctured 38 and almost completely punctured the remaining two specimens, thus suggesting that the new range 5 should be appreciably augmented. The arm of the GEPT was equipped with an electric strain gage which, together with other electric and electronic equipment, permitted the presentation, on the screen of an oscilloscope, of the force-distance relationship during actual puncturing of insulation board. The oscilloscope traces for the puncturing of a large number of specimens of various types of insulation board were photographed, and the photographs were translated to force versus distance charts for analytical purposes. The results of the analyses of these charts are given. Microflash pictures, taken from below and above the specimens at different stages of the processes of flexing and puncturing, were obtained for the purposes of studying the kinds of failure of different types of insulation board, and for such analytical purposes as estimating the degree of flexure of the specimen, and the completeness of flexural return of the specimen after puncture. Data were also obtained on the degree of flexure of the puncture arm of the GEPT. The present study does not include an investigation of the significance of puncture data with regard to the use of insulation board.

Drying of Insulating Board, H. C. JESSEN

The early history of the drying of insulating board is covered briefly. Then follows a general description of the various component parts of a modern roller drier as adopted for the drying of insulating board.

This description covers the drier structure, the feeding section, the discharge section, the air circulating system, and these various parts are illustrated by examples from existing installations.

The use of steam, gas, and oil as heating media is described, discussed, and illustrated.

A considerable portion of the paper is devoted to a discussion of the theoretical aspect of the drying of insulating boards in a roller drier. In this theoretical portion, the migration of moisture and evaporation is described, and it is pointed out that the drying takes place in three distinct stages. The effect of air velocities and temperatures in each of these stages is described.

In this portion of the paper a number of simple heat calculations are included. These pertain to gas-fired as well as steam-heated driers.

Drier efficiencies are discussed, and a formula developed for calculating the drier efficiency.

In the last paragraph of the paper a description is included of steps to be taken when starting up a new installation. The final portion of the paper contains a discussion of the various methods to be considered when it is desired to increase the capacity of a drier.

The Preparation and Use of Chlorine Activated Silica in Paper Mill Water Treatment, A. E. GRIFFIN AND M. S. CORNISH

The activation of sodium silicate with chlorine on a continuous basis has been investigated and found successful. Saturated chlorine water is added to full-strength sodium silicate. The combination is air mixed and aged in the same chamber. The activated silica is removed from the reaction chamber by an ejector. The water used to operate the ejector serves as dilution water. Activated silica thus prepared has been used to replace a glue formula in the operation of a Sveen-Pedersen saveall for one year.

Ozone Purification of Water, VICTOR HAHN

Advances in ozone technology and new commercial availability of large-size ozone generators have combined to spur research in

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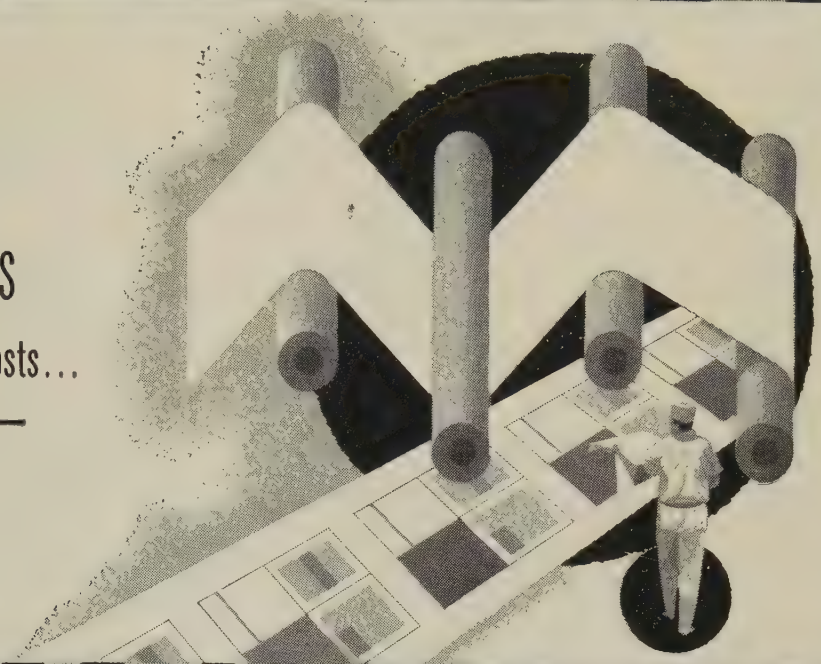

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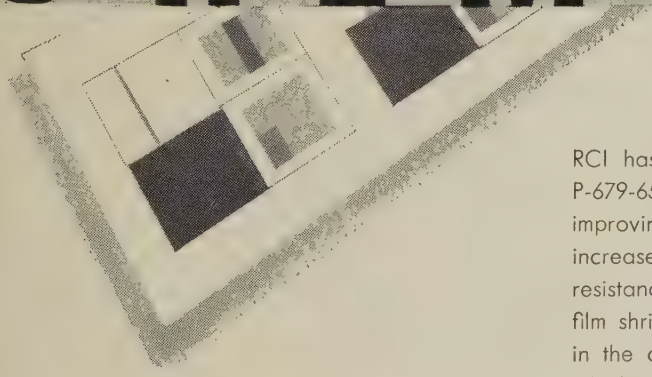

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industrial ozone applications. An extremely powerful oxidant, unique in that it consists only of oxygen in active form, ozone is finding many new uses in chemical oxidations, in water purification, and in the treatment of industrial wastes.

Ozone decomposes to ordinary oxygen in storage and therefore must be generated by the ultimate user at his own plant. Air or oxygen is compressed, dried, and passed through a special type of electrical discharge to form ozone.

Ozone has long been used as a germicide in drinking water, particularly in Europe. Recent developments have shown it to be an extremely effective means of removing tastes, odors, and color from water. As a result, large ozone plants to improve water quality have been installed in the municipal water systems of Philadelphia, Paris, and other cities.

A new ozone process for the destruction of phenols in industrial wastes appears to be the most efficient and economical means yet devised for reduction of phenol concentrations to the very low values required by governmental stream standards. In other industrial waste applications ozone is being used for oxidation of mercaptans in liquid wastes and for treatment of sewage gases to prevent atmospheric odor nuisance.

The Operation of an OCO Water System on a Board Mill's White Water, J. Howard Wright

The OCO water system installed at No. 2 board mill of the S. Austin Bicking Paper Mfg. Co., consists of a plate and frame filter, a slurry pump, and filter-aid feeder.

Segregated felt shower water is given primary sedimentation treatment followed by a pass-through plate and frame filter along with a controlled amount of filter aid (diatomaceous earth). The clarified white water is reused over and over as felt shower water under 105 to 110 pounds pressure.

A closed white water system is approached. This gives way to foam problems. Microorganism control is required.

Heat savings and chemical savings are noted.

Under normal operating conditions, a throughput of 110,000 to 130,000 gallons per 24 hours can be handled during one filter cycle.

Acetylation of Cellulose, R. C. Blume

While cellulose acetate has been produced from cotton for nearly 50 years, wood pulp has been an important raw material for this industry only within the past 15 years. One of the important factors retarding the development of wood pulp for this use has been the difficulty of evaluating its suitability for acetylation.

The problem of acetylating pulp evaluation has now been separated into two distinct parts: (1) processability in acetylation and (2) cellulose acetate quality. The first of these can be measured objectively and rather simply by the laboratory engaged in pulp development using the techniques discussed in this paper. The evaluation of cellulose acetate quality is more suitably carried out by the textile, film, or plastics industry.

The test to be described evaluates the acetylatability of pulps in terms of (1) over-all reaction rate, (2) the rate of degradation of the cellulose acetate being produced, and (3) the rate of disappearance of filter plugging particles from the acetylation mixture. These factors are determined accurately by periodic examination of the acetylating mixture during the later stages of an isothermal, sulphuric acid catalyzed, low consistency acetylation reaction.

The utility of the method is demonstrated by its application to the study of several alternative processes for the preparation of acetylating pulps from aspen. This work disclosed that products from prehydrolysis-sulphate and ammonia-base sulphite pulping of aspen acetylated with equal ease provided the proper combination of bleaching steps are chosen.

Purified Hardwood Pulps for Chemical Conversion. I. Aspen Sulphite and Prehydrolysis—Sulphate Pulps, F. A. Simmonds, R. M. Kingsbury, J. S. Martin, and E. L. Keller

The production from aspen of purified sulphite and sulphate pulps suitable for chemical conversion, especially acetylation, was studied at the Forest Products Laboratory. The work on sulphite pulps was done in cooperation with the Forest Products Div. of the Michigan College of Mining and Technology.

Aspen pulps were made by the ammonia-base sulphite process, using a liquor relatively high in free acid, and by the prehydrolysis-sulphate process, using only a water hydrolysis. Purification involved hot and cold alkaline extractions and oxidation with both sodium hypochlorite and chlorine dioxide.

The sulphite pulp, obtained in a yield of 51%, had alpha-cellulose and pentosan contents of 87 and 5.1%, and a viscosity of 37.4 cp. when dispersed at 0.5% concentration in cupriethylenediamine. This pulp was chlorinated and oxidized mildly with sodium hypochlorite. One portion of the oxidized pulp was extracted with a hot, dilute solution of sodium hydroxide and the other portion with a cold, concentrated solution of sodium hydroxide. Both batches were then oxidized with chlorine dioxide. The yield of pulp purified by hot extraction was 37.7%. The alpha-cellulose and pentosan contents of the purified pulp were 94.4 and 1.5%, and its viscosity was 30 cp. The yield of pulp purified by cold extraction was 44.4%. The alpha-cellulose and pentosan contents of the purified pulp were 96.3 and 0.3%, and its viscosity was 22 cp.

The prehydrolysis-sulphate pulp, obtained in a yield of 41%, had alpha-cellulose and pentosan contents of 92 and 2.8% and a viscosity of 37.7 cp. It was chlorinated, and one portion was given a hot alkaline extraction, and the other, a cold alkaline extraction. The second portion was oxidized with chlorine dioxide to give a yield of purified pulp of 38.2%. The alpha-cellulose and pentosan contents of the purified pulp from the second portion were 97.3 and 2.0%, and its viscosity was 18.4 cp.

The pulp given the hot extraction was divided, and one batch was oxidized with sodium hypochlorite to give a pulp yield of 37.6%. The alpha-cellulose and pentosan contents of the purified pulp were 94.7 and 2.2%, and the viscosity was 12.5 cp. The other batch was treated with chlorine dioxide to give a pulp yield of 37.7%. The alpha-cellulose and pentosan contents of the purified pulp were 95.5 and 2.5%, and its viscosity was 16.3 cp.

At an industrial laboratory, the two sulphite pulps and the two sulphate pulps purified by hot alkaline extraction were acetylated satisfactorily and made into yarn. The experimental cellulose acetate yarns obtained were as strong as yarn made from a commercial pulp of acetylation grade.

Evaluations of suitability for nitration and the viscose process were also obtained.

Polyamide Resin Suspensoids—a New Tool for the Paper Converter, Harold Wittcoff, M. M. Renfrew, and Fred B. Speyer

General Mills Polyamide Resins are thermoplastic condensation products of diamines and dimerized vegetable oil acids, which, for several years, have been available to the paper converter for hot melt and solution coating. They are now available in water dispersion or suspensoid form. Five types are marketed and several others are under development. The suspensoids are cationic and have an average particle size of 1 mu. They demonstrate excellent freeze-thaw resistance.

Films from the suspensoids are readily deposited. They dry rapidly; and, in order to obtain continuity, it is necessary to fuse them for a few minutes at about 120°C. The fused films demonstrate excellent resistance to water, water vapor, and to grease, as well as to dilute acid, alkali, solvents, and chemicals. The films give strong heat seals at low sealing temperatures. Furthermore, seals can be made to many surfaces including all types of paper, waxed paper, glassine, metal foils, metal, cork, asbestos, glass, coated cellophane, and other plastic films. In addition, the Polyamide Resin films demonstrate excellent resistance to blocking.

Because the suspensoids are cationic, they are compatible with polyvinyl acetate emulsions, and salutary effects are obtained from such blends. A procedure for the reversal of charge of the suspensoids is available so that they can be blended with anionic dispersions, such as natural and synthetic elastomer latices, vinyl and acrylic emulsions, rosin and wax emulsions, and casein dispersions. The suspensoids can be made compatible with most of the widely used paper coating materials. The compatibility relationships of the suspensoids will be discussed in detail.

The important uses of the suspensoids are as highly functional coating for paper and plastic films, and as heat-seal adhesives and laminants. They are also used as gloss overcoats. They are finding their way into wet stick adhesives where they provide heretofore unattainable water resistance. They show promise as beater additives in the fabrication of wet-strength paper. They may be used in tub-sizing compositions and as pigment binders for pigment coating of paper.

Commercial coating procedure for the suspensoids will be discussed.

Polyester Resins, Laminating and Molding Compounds, M. H. Bigelow and P. E. Nowicki

Shortly after the start of World War II, polyester resins emerged from the laboratory and, combined with glass fibers, became the raw material for a number of military items, such as radomes and aircraft parts. Sales rose to a relatively high level and after the war they dropped to a very low level. High costs and inefficient manufacturing techniques mitigated against their use.

Our present defense program has again stimulated interest in polyester glass reinforced laminates and once again sales are soaring. This time, however, it is gratifying to note that a fair share of sales is devoted to civilian items. These low pressure laminates were not readily adaptable to conventional compression molding techniques. This left a serious void in the over-all high strength plastics picture. This void has since been filled by the new reinforced alkyd molding compounds announced by the Plaskon Div. of the Libbey-Owens-Ford Glass Co. Now it is possible to mold innumerable end items having high strength and utilizing existing equipment.

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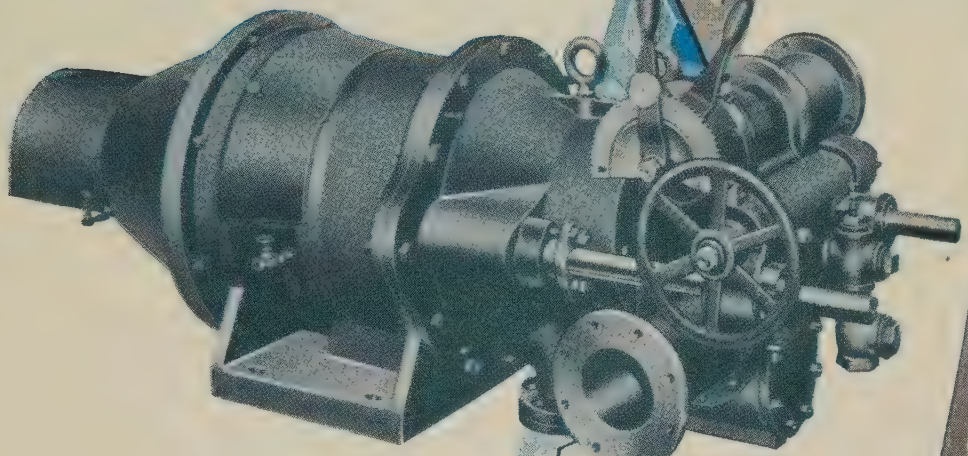

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Significance of Laboratory Sizing Data, Ell Dee Compton

Laboratory paper sizing data are used to illustrate some of the pitfalls that may be encountered in interpretation of such data.

The utility of a simple experimental design and analysis of variance in such work is then illustrated using actual laboratory data.

Management Reviews a Controlled Operation, W. A. MacCrehan

Three things are essential to good management: (1) knowledge of the process, (2) proper equipment to perform the task, and (3) control of variables sufficient to yield a profitable enterprise.

The first of these essential items must be inherent with the technical staff employed in the manufacturing plant.

The second item must be the outgrowth of experience with manufacturing equipment and development research applied to use of the equipment.

The third item incorporates estimating, accounting, organization, materials flow, and waste control.

Time has been a valuable ally in assisting modern manufacturing in (1) and (2). Through the years the development of schools to train personnel and aggressive research into pulp and paper machinery, stimulated by increasing competition, has solved many problems affecting technical staff and equipment.

The third item has had many new ideas advanced to keep management abreast of manufacturing gains and losses. Prime among the newcomers is the technique of statistical quality control. This application of industrial statistics does keep management informed of the progress attained in keeping the variables encountered within the economic limits of controlled production.

A typical job process from mill to factory is studied under quality control guidance in the following presentation:

Mill—Specification
1. Ability to meet specification.
   a. Process capability study.
   b. Running chart by subgroup sampling.
2. Inspection for conformance.
   a. Histogram check of weight, caliper, moisture, finish, drip, pick. Sampling method for data collection.
   b. Shipping sampling (visual) through check list.

Factory
1. Receiving inspection.
   a. Audit of incoming board order-sampling through "p" rating.
2. Press operation—printing.
   a. Control chart by lot plot.
   b. Follow-through of correction.
3. Press operation—cutting.
   a. Control chart by lot plot.
   b. Follow-through on correction.
   c. Visual inspection of printing quality—rating sheet—identification of loads.
4. Stripping operation.
   1. Sampling by "P" level.
   2. Visual post chart.
5. Gluing operation.
   1. Review of limits.
   2. Determination of inspection.
   3. Sampling by "P" level audit.
6. Warehouse inspection.
   1. Customers' representative review.
      a. Count.
      b. Quality—visual.
      c. Packing method.
      d. Recommendations.

The yardsticks to judge economic gains for controlled process production are: (1) customer satisfaction, (2) low cost of high quality, (3) smooth production flow, (4) waste and spoilage reduction, and (5) employee pride and morale.

Case Studies in the Application of Industrial Statistics to Papermaking, Part II, Charles A. Bicking and R. T. Trelfa

The case studies in this paper are a natural extension of the five practical applications of industrial statistics to papermaking described in Part I published in *Tappi* 34, No. 8 370–380 (Aug., 1951). Following a predetermined plan these new case studies involve slightly more sophisticated statistical techniques than the earlier ones. However, the limitations of a rigorous approach to solution of problems at the operating level have been kept in mind. Anyone with a moderate aptitude for mathematics or with even slight exposure to developments of the past decade in the field of statistical quality control will have no difficulty in putting to use the methods described in this paper.

Some of the pitfalls in the control chart analysis of mill data in an effort to attain process control are considered. It is pointed out how much a rational arrangement of the data depends upon intimate experience with and clear thinking about the working of a paper machine. Preparation for keeping a control chart requires a high order of ability in planning.

Another problem described is the commonly encountered one of trying to make some sense from visual examination of a material resulting in a score rather than a measurement. An example is given of an extensive program for rating the printability of several different kinds of paper.

Although every application of statistical methods involves preplanning for the collection of data, there is a whole area of statistics, called design of experiments, which has wide application in the planning of mill investigations. A generalized plan for experimentation is presented, as follows:

1. Obtain a clear statement of the problem.
2. Collect all available background information.
3. Design the investigation.
4. Perform the experiment.
5. Analyze the data.
6. Interpret the data.
7. Prepare a report.

The operation of this plan in a simple mill investigation is described in the paper.

Résumé of Replies to Starch Adhesives Questionnaire, Burt Mendlin

The industry questionnaire, which brings us together this morning, is the first of its kind. It represents the first time that the corrugated box industry has formally pooled technical information for the betterment of the industry. In spirit, I feel that the questionnaire epitomizes the aim of the Technical Association. The results have been most gratifying to all of us who have worked on the questionnaire, and I am sure proved profitable to at least the participating companies.

The idea of the questionnaire was first conceived in June, 1950, as the first effort of the Corrugated Containers Committee. The questionnaire was completed by August, 1950. It was distributed in November to 42 companies in the United States and one in Canada. The returns, in by March, 1951, were collated in May and the résumés distributed in July to the participating companies—33, representing 49 plants.

Starch Formulations and Control of Starch Viscosities, J. E. Killinger

Basic corrugating starch formulas for producing both regular and waterproof adhesives and the functions played by the various ingredients are discussed.

The functions of the carrier and raw starch portions, the various types of starches employed, and the methods of preparing the completed corrugating starch are given, with special emphasis on degree of hydration, amount of bound water, effectiveness of additives for producing water resistance, pot life, and machine speeds.

The importance of a constant viscosity tailored for the various machines is explained. Comparisons between native and converted starches with respect to viscosity stability are drawn. Effect of hydrophilic colloids is mentioned. Details for producing a chemically stabilized starch carrier are given. A brief description of mechanical equipment for controlling viscosity variations is presented.

Advantages and Disadvantages of One vs. Two Starch Systems, E. S. Gant

The viscosity of starch paste is usually a compromise between the ideal used for a single facer and for the double backer. There recently has been shown interest in the possibility of using two systems, one to apply a thin paste to the single facer and the other to provide a heavier paste for the double backer. In some instances this may be advantageous, in the majority, however, it is believed that the additional complications of two systems are not warranted by the results.

Fluff, Flutter, Fingerlines, and Other Operational Problems, S. Drum

The operational problems of a corrugator must be specifically described because of differences in equipment, materials, and personnel. However, to solve any problem consideration must be given to: (1) realization of the problem, (2) correct analysis of difficulty, (3) desire to solve it, (4) ability to handle the problem, and finally (5) the human relation aspects.

Heat Balance on a Corrugator, R. T. Cassady

Not too long ago, little thought was given to the heat problems on a corrugator primarily because the operational speeds were low. Now, however, with fast modern machines the mechanical problems being more or less solved, the capacity of the unit is determined by the heat transfer. It is known that the steam load will vary dependent on the running conditions and efforts should be made to determine the point where production and maximum heat transfer are in balance. Consideration should also be given

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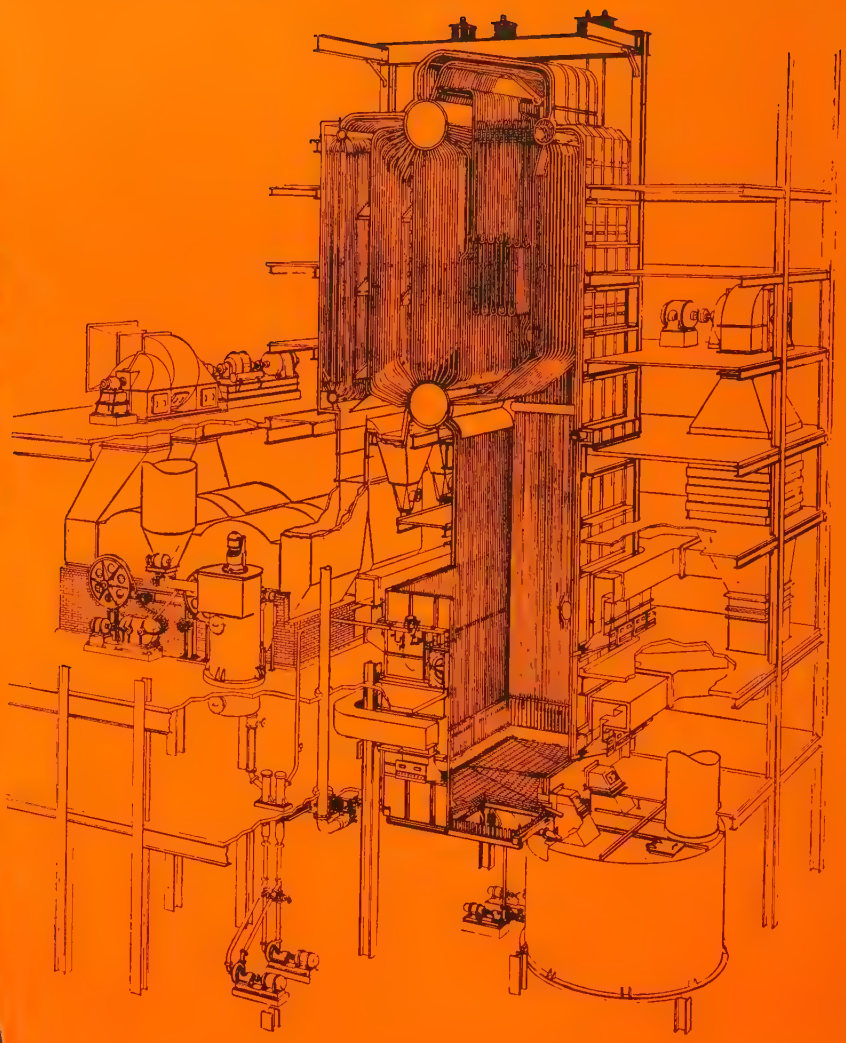

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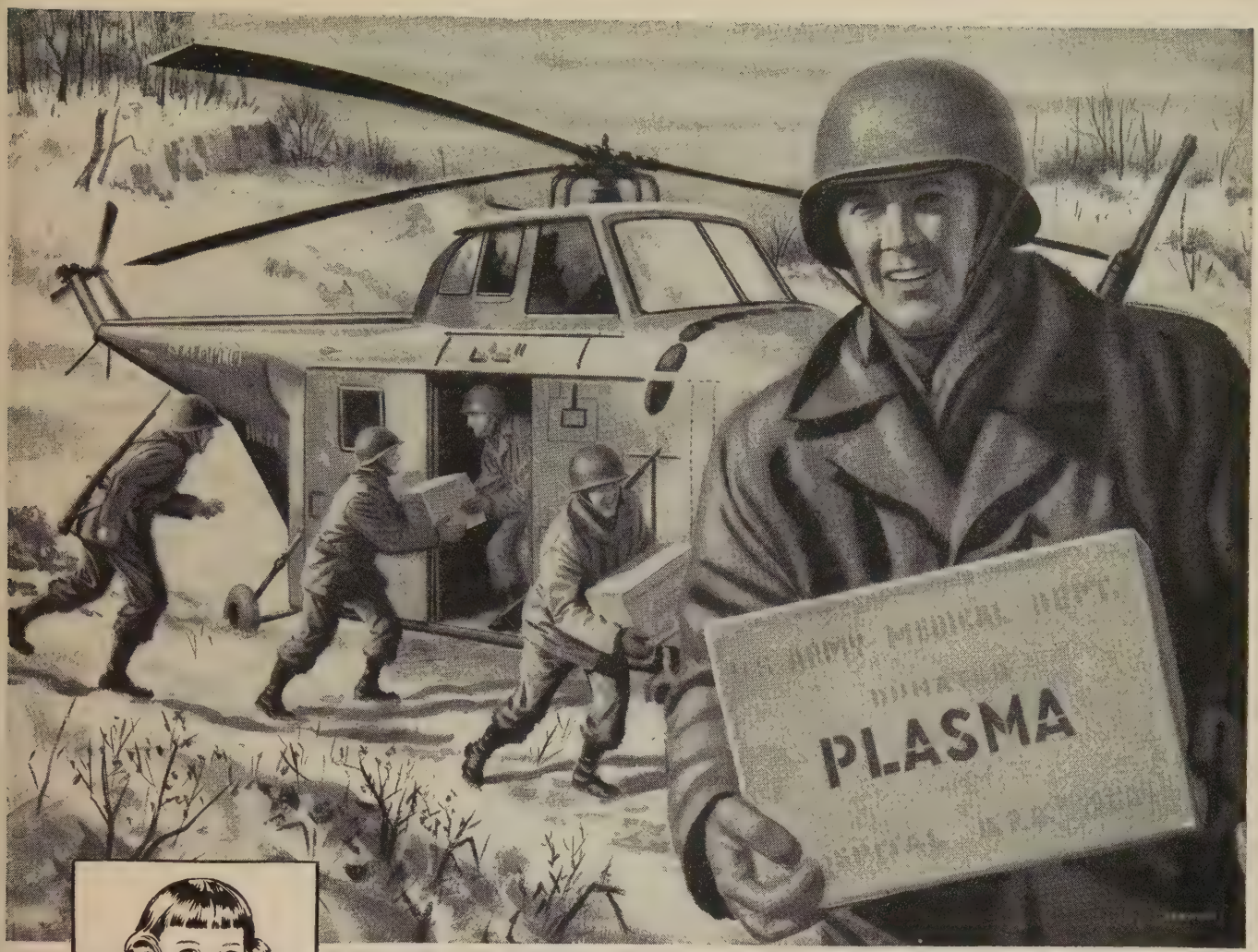

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to the boiler conditions as well as the piping arrangements to secure the most favorable results.

Testing and Quality Control, D. P. McNelly

Other industries have found it desirable to inspect their products before they are delivered to the consumer. Most box makers are depending upon tests on finished boxes, made usually after the boxes have been shipped.

It is becoming more popular to provide inspectors in the plant, to check at each manufacturing operation, watching the boxes as they are being made in an attempt to control quality closer, and to ship a better product.

An inspector working at the end of the doublebacker using a caliper, examining the adhesion, and perhaps making a test to measure strength in some way, can help assure the quality of the board being manufactured. If these tests are supplemented by checks at the other machines, at which the boxes are being run, it should assure a better quality box for the customer.

Mechanical Correction of Two-Sidedness, M. J. Landberge, P. R. Schreiber, and H. H. Behrens

The primary causes of two-sidedness are given as heterogeneity of fiber furnish, fillers, and coloring matters.

Structural two-sidedness caused by unequal length and density of fibers is almost impossible to correct since the fines are removed from the wire side in preference to the long fibers. Two-sidedness due to fillers is closely allied to the structural type but is more readily balanced by replacement of filler at the guide roll, size press, or at a coating unit. Duplexity due to color is probably the easiest type to correct.

In heavily loaded sheets proper choice of dyestuffs and pigments to color the filler and fiber in balance may yield even-sided sheets. On the other hand, sheets with little or no filler content cannot be controlled in this manner. The means of correction recommended here is that of staining the wire side of the sheet at the size press with some attention given to coloring at the guide roll.

Various installations in use in the United States and Canada are discussed. In general, the equipment which is simplest from the engineering standpoint requires most manual control. If more attention is given to the details of construction and of equipment less dependence is placed on the machine crew or colorman for keeping both sides of the sheet in balance. Seven schematic diagrams are shown to illustrate these statements.

The Use of Graphic Panels in the Paper Industry, Donald B. Scrivens

Graphic-type panels have been used by the power industry for many years but the process industries have begun to use a more highly developed form of the graphic for industrial control. A graphic panel is defined as "a central control panel on which appears facilities for maintaining control and obtaining records in addition to a process flow diagram showing the major process equipment, all panel instruments being located on the flow diagram relative to their actual point of control in the process." The components of transmission control systems used on graphic panels are the transmitter, controller, and recorder. The features of each of these are described and their relation to the panel and each other outlined. A comparison of the conventional and graphic control systems with regard to space required, cost, usefulness in operation, and maintenance of instruments, shows that the graphic panel has definite advantages. Panel space as high as 60% may often be saved with an accompanying decrease in over-all installed cost saving up to 15%. The graphic panel is very useful in the training of new personnel, it materially eases the operating functions in the detection of upsets and start-ups as well as for normal operation. Because of unit construction and standardization of the instruments, maintenance is reduced.

Because of their complexity, the area they cover in the mill, and the interdependency of equipment operation, the sulphite acid plant, sulphate liquor recovery system, groundwood screen room, stock preparation section, and bleach plant are good locations for application of a graphic panel and control system. The graphic panel performs the following functions:

1. Provides complete facilities for control.
2. Shows continuity of processing.
3. Is compact for easy operator supervision.
4. Provides for a minimum variation of panel instrumentation.

The Beatapulper, Arthur W. Infanger

The best features of the Cowles Knifemill, which is now in the final development stage, and the Cowles Side Drive Pulper (now called the Aquapulper) have been combined in one unit, the Beatapulper, which efficiently performs the functions of pulper beater, and refiner. The unit can be furnished like a pulper, and the stock is slushed, defibered, refined, hydrated, and shortened as desired before dumping. The Beatapulper is normally operated on a batch cycle, and size, color, alum, or other chemicals can be added in the pulper. The pressure between the rotating knives and the movable refining ring is adjusted by means of three hydraulic cylinders. A relatively light pressure gives a good brushing action on the fibers and results in considerable strength development.

A comparison of results obtained with the Beatapulper and a standard commercial refiner, using 100% bleached Tacoma kraft furnish in 68°F. water at 4½%, gives the following values at the end of the runs (22 hp. per ton per day)

	% Bursting strength	*C.S. freeness*	*% Tear*
Beatapulper	106	475	258
Refiner	66	182	115

The complete curves show many interesting characteristics and it is pointed out that the Beatapulper power figures include the pulping power, whereas the pulping power must be added to the refiner power figures.

Performance curves and operating characteristics are discussed for various furnishes now being processed in a Beatapulper in actual mill operation. This Beatapulper is of the 10 SD 8 size, and operates on a batch cycle holding 2000 pounds of 5% furnish.

Handling Materials in the Paper Industry, L. O. Millard

The problem of materials handling in all industry is a challenge to the engineering profession, and certainly the pulp and paper industry with its approximate annual production of 24,000,000 tons of paper is one of the nation's most important.

The importance of materials handling equipment in the paper industry is further emphasized by the fact that, for every carload of paper shipped from a mill, at least four carloads of pulpwood, chemicals, coal, and other materials must be processed. In these trying days of inflation, price controls, and the high cost and shortage of both labor and materials, mechanization of materials handling operations is of prime importance.

Physical handling of materials, whether it be manual or mechanical, adds cost only. It is a necessary evil that adds absolutely nothing of marketable value. Therefore it is not surprising that mechanization of one mill's wood room, for example, resulted in an estimated saving of $100,000 annually. Shifts were reduced from three to two, wood saving was accomplished through greater wood utilization, and there was a reduction in maintenance.

Both new and modernized, large and small pulp mills throughout the north, south, east, and west, will be shown to illustrate the application of materials handling equipment and the part it is playing in reducing costs in the production of paper—from receipt of raw materials to the shipping room.

The Hammermill Dirt Separator, E. L. Rastatter and A. H. Croup

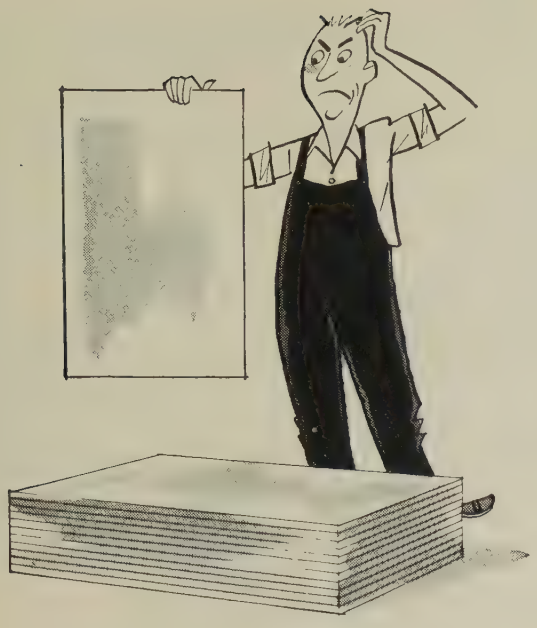
The development of a centrifugal-type cleaning device for pulp and paper furnishes is described. This separator was designed specifically for the removal of small, low specific gravity speck dirt. Details of the developmental procedure are given. Very good efficiency in the removal of impurities of both wood and nonwood origin is indicated. Long, slender shives are not effectively removed. The details of a small installation in operation for over ten years are given, and the plans for a commercial design based on the use of these units are described.

The Chlorine Dioxide Bleaching Process Can Be Used Advantageously by Paper Mills, H. R. Murdock

In spite of ample evidence that chlorine dioxide is a splendid chemical for bleaching wood pulp, the paper industry hesitates to adopt the process. This postponement is not because of shortages in materials of construction or chemicals. It stems from indecision as to whether chlorine dioxide bleaching is economically adaptable to paper mill operations. The industry seems to believe that the process necessarily requires burdensome capital expenditures and involves technical knowledge beyond the present requirements of the average paper mill. For these reasons, they have preferred that market pulp mills use this superb bleaching process in mass production in order to meet the paper mill needs for an ultra-strong, high-white wood pulp. However, chlorine dioxide bleaching can today be a very useful, flexible process for use in the paper mill. The paper discusses these advantages.

Pilot Plant Recovery of Heat and Sulphur from Spent Ammonia-Base Sulphite Pulping Liquor, J. H. Hull and G. V. Palmrose

Operation of a pilot plant at the Lebanon, Ore., mill of the Crown Zellerbach Corp. for studying evaporation and burning of ammonia-base spent liquor with recovery of sulphur from the



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resultant flue gases has demonstrated the practicability of the process.

The pilot plant took the liquor from 10 tons of pulp per 24 hours, concentrated it from 9 to 50% solids, and burned it under a boiler. Sulphur dioxide was recovered from the flue gases by scrubbing them with ammonia solution. The resultant ammonium sulphite-bisulphite solution was returned to the mill acid plant for addition to the raw acid.

The evaporator was a single-effect Conkey flat plate heating surface-type with 2200 square feet of heating surface. It had no condenser and was operated as a falling film evaporator. Two circulating pumps were supplied for employing the Rosenblad channel switching system for control of scaling.

Continuous circulation of condensate over the plates with channel switching every 8 hours gave adequate control of scaling. This was true even though the condensate contained no acids. In a multiple effect evaporator where the condensate contains some acids this method should be even more effective.

No trouble with polymerization of the liquor was encountered.

The burning work indicated that for good combustion a refractory furnace ahead of the boiler should be employed. However, conversion of a hogged fuel-fired boiler involves only the removal of the grates from the Dutch oven and the addition of some duct work and brickwork.

Steam production was well over 10,000 pounds per ton of pulp.

Burning liquor from salt water-borne logs increased the fouling rate of the boiler tubes and gave a sticky deposit on them.

The absorption system consisted of a direct contact cooling tower and an absorption tower. Both were packed with 3-inch spiral tile.

Useful sulphur recovery varied from 100 to 125 pounds per ton of pulp.

Sulphur as sulphates varied from 5 to 9 pounds of sulphur per ton of pulp.

Only a trace of ammonia was found in the cooling tower effluent.

Severe corrosion was encountered in the cooling tower system when operating on liquor from salt water-borne logs. This was due to the formation of hydrochloric acid from the salt carried over into the tower.

In general very little process trouble was encountered. The conversion of a mill to the ammonia-base process should be relatively inexpensive since the furnace is relatively simple and the absorption system requires no extremely high towers. Equipment is on order at present to provide full scale evaporation and burning at Lebanon.

Acid Pulping Committee Report on TAPPI Strainer and Circulation Survey, JOHN M. MCEWEN

The TAPPI Acid Pulping Committee sent a questionnaire on strainers and forced circulation to 61 mills. Most mills having forced circulation are convinced that it gives them better pulp uniformity and quality. Some mills report better circulation than others. Answers to a questionnaire cannot equal a carefully controlled experiment since all factors cannot be covered, in some categories there are too few replies, and some mills may misinterpret a question and thus give a false answer. Recognizing these shortcomings, the survey showed mills with the following equipment to report the best circulation:

1. Split circulation better than top to bottom.
2. Hydroheaters or indirect heaters better than direct heaters.
3. Medium free SO_2 better than that over 7%.

There was disagreement in the data or opinions expressed on the following points:

1. Location of strainers—most preferred strainers at 50% of volume or lower but data did not show low strainer mills to be consistently better and one mill reported a study showing no great difference.
2. Strainer area—some mills report better results when small strainer area is used to increase velocity through strainers, yet high velocity mills reported some of the worst circulation.
3. Removal of side relief—most of the best circulating mills did not remove side relief close to strainers, yet mills reporting very close removal of side did not show poor circulation.

The following items did not correlate with the reported ability to circulate:

1. Amount of chip packing.
2. Normal variations in cleaning strainers.
3. Degree of cooking (final permanganate number).
4. Maximum temperature.
5. Length of cooking cycle.

Sulphate Formation and Its Effects on Sulphur Usage, GEORGE KNIGHT AND M. S. ANDERSON

Recent developments in the recovery of waste liquors and methods of steaming and circulating the digesters, combined with the present sulphur shortage, have increased the importance of sulphate formation in sulphite pulping.

A series of mill trials were made to determine the effect of dolomitic lime, sequestering agents, increased free sulphur dioxide concentration, and the elimination of external steam injection devices on sulphate formation. Of these, the use of bottom digester steaming instead of steaming through the circulating systems, proved most satisfactory.

In this mill, operating on calcium base liquors made from kraft sludge, sulphur losses due to sulphate formation were found to be approximately 44 pounds per ton of bleached pulp. Technical studies showed that, in this mill, about 80% of the sulphate formation occurs in the digester, principally due to the presence of colloidal sulphur and air.

The validity of the results obtained while operating on calcium base has been confirmed by conversion to sodium base where a predicted reduction in sulphate formation of approximately 65% was obtained.

Modern Developments in Welded Barking Drum Design, GEORGE M. DICK

The removal of bark from pulpwood by means of drum barkers continues to be the most economical of all barking processes for normal size logs, and barking drum design, therefore, continues to be of considerable interest to the majority of pulp and paper manufacturers. The wide variety of ideas underlying this design is an interesting study.

Originally, most of the barking drums manufactured were of riveted construction or of combined riveted and welded construction. Riveting techniques being then of a highly developed nature and used in a variety of pulp and paper apparatus permitted repairs to riveted barking drums to be easily made. The gradual swing to welding for pulp and paper equipment made riveting less desirable and welding much more acceptable.

The various welding supply manufacturers as well as the welding societies and such other organizations have done much in recent years to provide improved welding materials and techniques. Early attempts to weld barking drums were only partially successful, and eventually a complete analysis of the underlying principles was made in an endeavor to establish the factors which would contribute to successful all-welded barking drum design.

By enlarging the field of study sufficiently, the benefits of welding experienced in other forms of welded structures were included and eventually, a number of definite factors established as guides in welded barking drum design.

The inclusion of these basic fundamentals in a modern design of all-welded barking drum is interesting and shows how maintenance costs which are a vital factor in barking expense are likely to be greatly reduced with the introduction of this latest form of barking drum construction.

Dye Adsorption on Wood Pulp. I. Adoption of Direct Dye on Unbeaten Sulphite Pulp, J. W. BEAMESDERFER, E. F. THODE, A. J. CHASE, AND R. E. HUBBARD, JR.

In an attempt to develop a simple and rapid method for the evaluation of the specific external surface of pulp fibers, a study was made of the adsorption of a direct dye on fibers from dilute aqueous solutions. Isotherms at 25°C., for the adsorption of Benzo Fast Scarlet on unbeaten fibers from bleached sulphite pulp, are presented. Specific adsorption of dye (milligrams of dye adsorbed per gram of dry pulp) was plotted as a function of final dye concentration and isotherms of the Langmuir-type were obtained. From a knowledge of the saturation value in the adsorption process, as determined from the isotherm, and from a knowledge of the area of the dye molecule presented for adsorption, calculation of an "apparent" area of the fibers is possible.

An attempt was made to separate the process of adsorption on the external surface of the fibers from the slower process of diffusion of dye into the microscopic and submicroscopic pores and crevasses. Results are presented on experiments designed to give information concerning the effect of electrolyte concentration.

A comparison of apparent specific surface of fibers obtained by this dye adsorption method with areas obtained by the well-known silvering and liquid permeability methods is presented.

Dye Adsorption on Wood Pulp. II. Relation of Dye Adsorption to Physical Properties of Beaten Sulphite Pulp, E. F. THODE, J. W. BEAMESDERFER, AND A. J. CHASE

The application of a technique of adsorption of direct dye from dilute solution to the evaluation of properties of beaten pulp fibers is described. Correlation of the specific adsorption of dye, in milligrams of dye per gram of dry pulp, with beating time and with the physical properties of handsheets is reported. The relationship of this specific dye adsorption to the external specific surface as determined by the silvering technique and the permeability technique is also reported and discussed.

It is concluded that the specific adsorption of direct dye under

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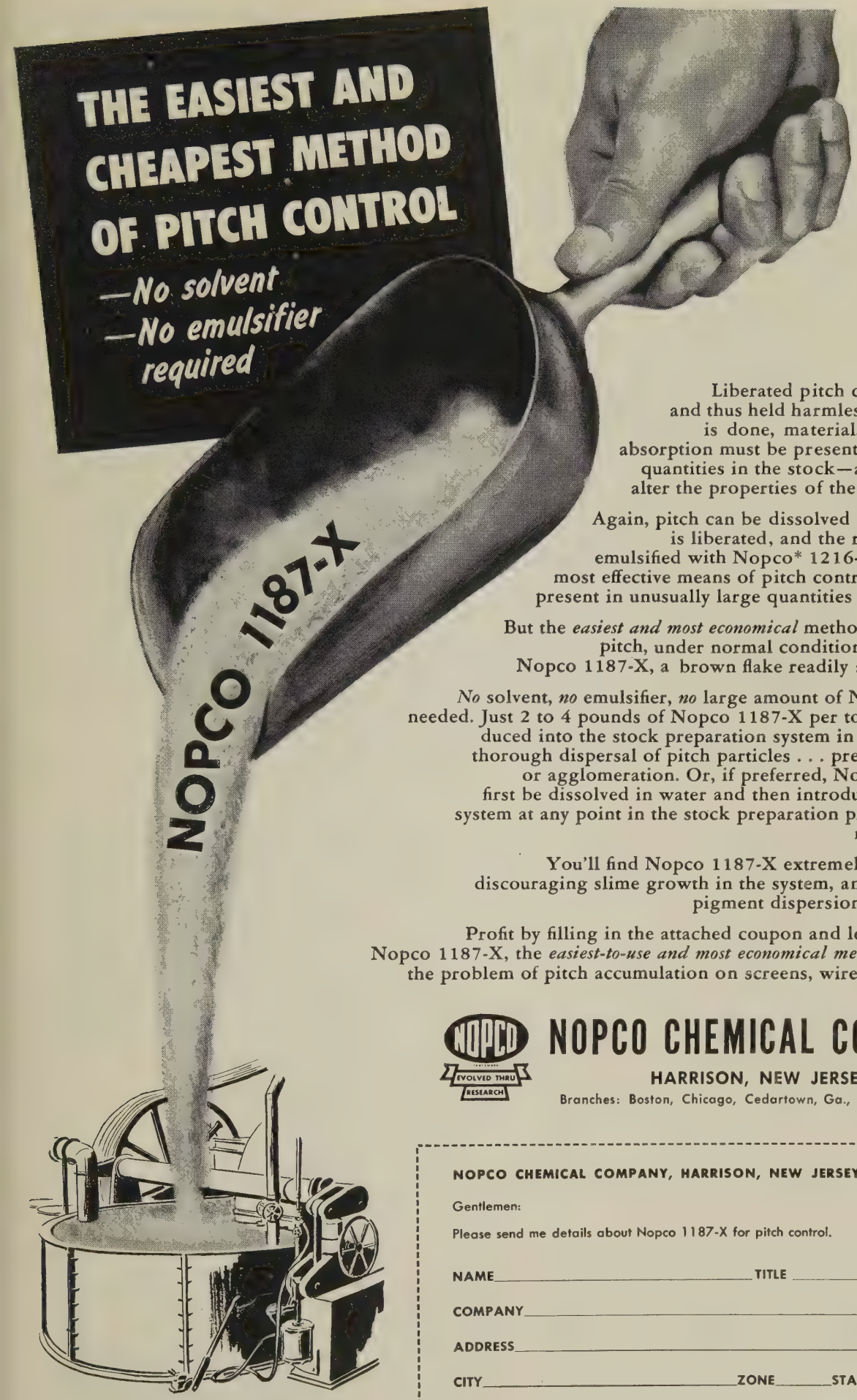

Liberated pitch can be absorbed, and thus held harmless. But when this is done, materials used for pitch absorption must be present in considerable quantities in the stock—and this tends to alter the properties of the pulp and paper.

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the experimental conditions employed is directly related to the external surface of pulp fibers.

The specific adsorption of dye in the absence of electrolyte, which has also been studied, is shown to increase with beating at a rate materially different from that found in the presence of electrolyte. Further investigation into the fundamental significance of this phenomenon is thought desirable.

The Ignition Temperature of Certain Pulps and Other Wood Components, M. A. Buchanan

Sulphite and kraft pulps have an ignition temperature of about 260°C. as determined by a method utilizing a relatively short heating time. The ignition temperature of groundwood and semichemical pulps and wood is in the range of 210 to 230°C. The difference is due to lignin and hemicelluloses, both of which appear to have an ignition temperature of about 180°C.

The Manufacture and Properties of Chlorine Dioxide, E. Kesting

Commercial interest in chlorine dioxide has greatly increased since the last war, and it is now particularly the wood pulp industry which is concerned with its manufacture and application.

Although it is a chemical of considerable latent energy, which is ready to initiate explosive reactions with almost any combustible or oxidizable matter, safe and efficient ways have been found for its manufacture and handling. The problem of transporting it in compressed or liquid state has, however, not yet been solved and it is necessary, therefore, to make it at the place of application.

Sodium chlorite is available for this purpose but the rather circuitous steps involved in this procedure lead to high costs and restrict its use severely.

Other industrial procedures now carried out at various mills were founded on the use of solid sodium chlorate and its conversion first into chloric acid and the reduction of the latter to chlorine dioxide by various agents. The basic intention in each case is to obtain in one step or in a series of simultaneous steps a maximum yield of chlorine dioxide from the expensive chlorate as the accruing waste products prohibit the reuse of the exhausted liquor. Much stress is also put on making the dioxide as free of chlorine as possible. Due to the ease with which both can be separated, these efforts seem rather pointless.

The Kesting process, which has already produced several hundred tons of chlorine dioxide, follows a different pattern. It makes chlorine dioxide from hydrochloric acid, water, and electric current. The carrier for the oxygen needed in the oxidation of the hydrochloric acid is a solution of sodium chlorate, which continuously circulates between the dioxide reactor and an electrolytic cell for fortification. No sodium chlorate and no sodium chloride—the initial charge excepted—need to be purchased and there are no waste products. The process is continuous and exceptionally well suited for automatic control. The cost of the chlorine dioxide thus produced closely approaches that of hypochlorite chlorine, both measured on active basis.

The Air Drying of Paper, James J. Higgins

Although air drying of paper represents only a small part of the drying carried out by the industry, it is believed to be the most fundamental and, therefore, has been studied as a basis for the determination of the mechanism of drying on hot surfaces. The results show that the paper sheet does not dry at a uniform rate from the leading to the trailing edge. Freeness (from 470 to 800-ml. Schopper-Riegler), formation, and the number of plies have no effect on the rate of drying during the constant rate period. The moisture distribution within the sheet was also studied; this varied slightly with the initial moisture content and appears to be independent of the freeness of the sheet and the rate of drying between 100 and 25% moisture. A mechanism for the flow of moisture during drying is proposed.

Résumé of Replies to Silicate Adhesives Questionnaire and Remarks on Efficient Use of Silicate, E. G. Boyce

A presentation of the summary of data from replies to a questionnaire was received from twenty manufacturers of corrugated board using sodium silicate as the adhesive.

Questions on handling sodium silicate, its use, consumption, etc., will be reviewed with comments on the efficient use of sodium silicate.

Effect of Varying Compositions of Silicate on Corrugator Operation, J. G. Lander

Silicate of soda is a compound of silica (SiO_2) and sodium oxide (Na_2O) in aqueous solution. The ratio or proportion of sodium oxide to silica, and the specific gravity or Baumé of the solution are critical factors in tailoring silicate to the job of efficient corrugator performance. The ratio range has over the years narrowed down to $1Na_2O:3.22\ SiO_2$. Generally speaking the higher silica ratios produce faster setting; low silica ratios produce slower setting.

Specific gravity or Baumé covers a wider range, and because it denotes concentration of solution it is very critical and must be adjusted to the operation, particularly with the high silica ratio silicates.

In choosing optimum specific gravity or Baumé careful consideration must be given to: (1) type and condition of equipment, (2) geographic location, (3) steam pressure available, (4) kinds of linerboard and corrugating mediums used, (5) prevailing types of corrugated board produced, (6) standard of quality to be met, (7) possible machine improvements and adjustments.

Silicate manufacturers hold the production of their various grades of silicate of soda under close control and use utmost care to deliver same to exact specifications, thereby freeing the box maker of the problem of adhesive control.

Proper Mechanical Adjustment for Good Corrugator Operation, C. O. Kreegar

Management must have a definite program for maintenance, if the plant is to operate efficiently. Through regular inspection and repair of worn or defective parts production time can be increased. The quality of the maintenance personnel is also an important factor which must be considered.

Clearances on the Corrugator, Charles D. Nitchie

From the machinery builder's viewpoint, the most important factors affecting corrugatability are:

1. Design and production of a flute contour which would produce board of high strength, and at the same time be compatible with the physical properties of paper.
2. Maintenance of adequate temperatures at the surfaces of the corrugating rolls.
3. Maintenance of intelligent adjustment of the adhesive mechanism to achieve adequate bonding of the single-faced without distortion of the accurately formed flutes.

All three of these factors are of equal importance, and any one of them can have a detrimental effect on the quality of board produced, even though the remaining two are ideal.

The type of adhesive being used, absorptive properties of the paper, Rehle test, roll temperatures, speed, and many other factors combine to make roll settings variable from plant to plant, and even hour to hour in the same plant. However, it is suggested that closer clearances be attempted. There is much to be gained in improved quality, and particularly as regards high and low flute and skips, lower adhesive costs, and longer finger life.

Steam Supply and Evacuation, J. E. Wilske

The art of fabricating corrugated paper can be classed as a thermomechanical process since heat must be associated with mechanical arrangements to properly form the corrugations and adhere liners thereto.

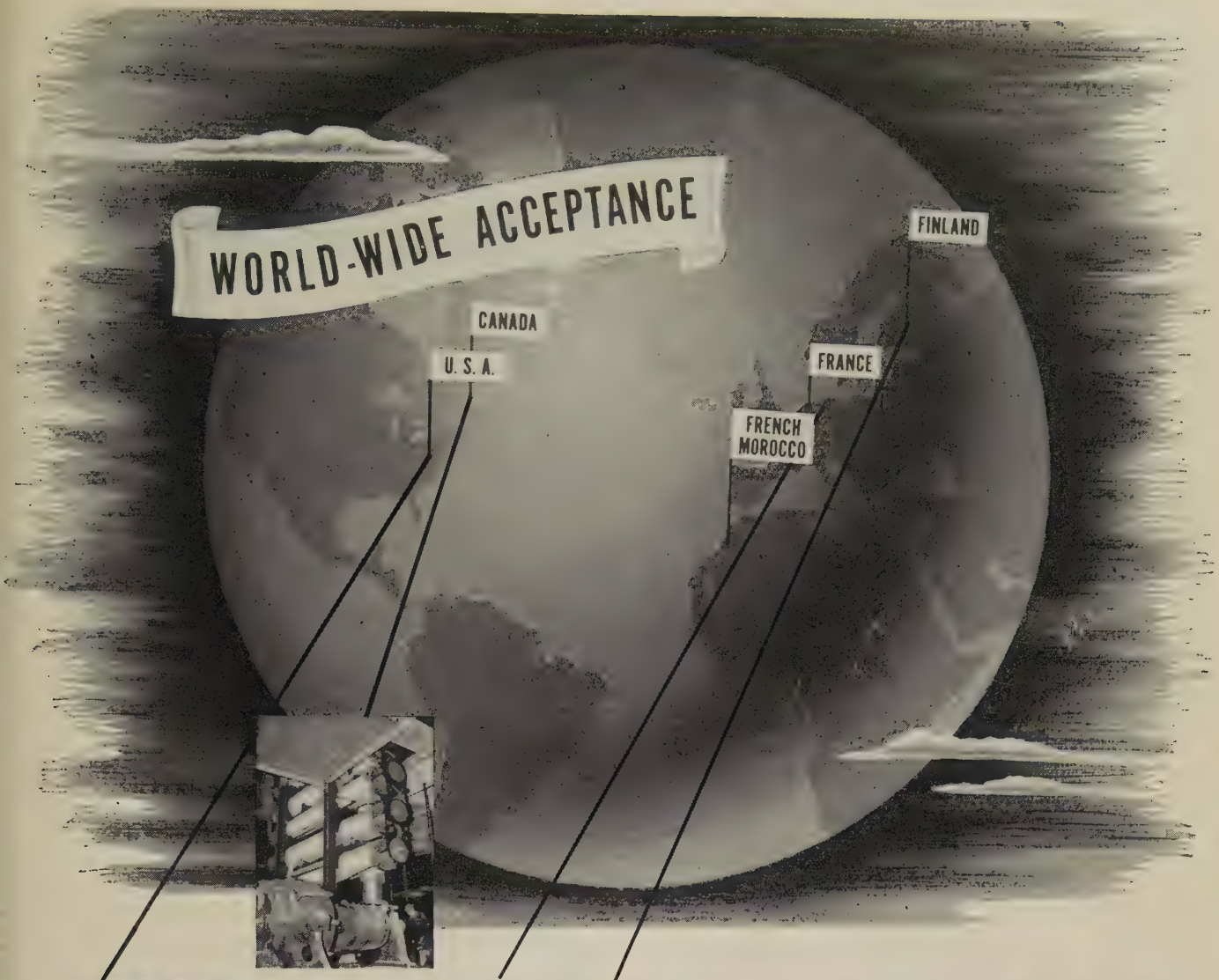
The résumé of the silicate questionnaire indicates a good cross section of existing thermal conditions in use today on corrugating rolls, preheaters, and double-face ovens. This discussion elaborates on existing thermomechanical requirements on these elements as well as possible or desirable future trends necessary to overcome certain operating problems.

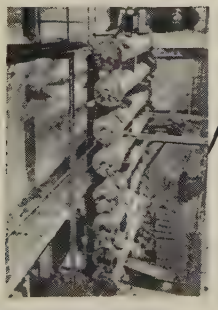
A Method of Laboratory Evaluation of Chemicals as Potential Slimicides, S. I. Cohen and Marcine Kahm

In the initial screening of chemicals as potential slimicides frequent variability of antiseptic data has been encountered from test to test. Using standard methods, it is often impossible in our laboratory to distinguish between such variability and any intrinsic toxicity associated with the chemical structure of similar compounds. This was found to be especially true for mercurials. To reduce this variation, the standard Petri plate method of Appling and McCoy was modified to improve the accuracy of several steps by (1) standardization of inoculum to 1 million organisms per cc., (2) thorough mixing of chemical and melted agar in test tubes before pouring plates, (3) addition of inoculum to cooled, melted agar instead of surface streaking, (4) extremely accurate dilutions of the chemical. In spite of these modifications, no significant improvement occurred in accuracy and reproducibility. This suggested that the type of medium is an important factor.

A synthetic liquid medium was adopted and used in a test tube technique. One milliliter of a dilution-series of the chemical is added to 9 ml. of the medium, followed by 0.1 ml. of inoculum. The tubes are agitated by hand at fixed intervals or continuously on a shake-table. After 24 and 48 hours of incubation, turbidimetric measurements are made yielding germistatic data. Information about germicidal action and killing time are obtained by combining the chemical dilutions with the inoculum for arbitrary time intervals before loop transfers are made to media tubes. The latter procedure also permits evaluation of chemicals that cannot be added directly to the synthetic medium.

The above technique has proved reproducible and accurate at least to 7.7% with compounds that could not be assayed with the plate method. Three bacteria and one fungus were employed





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satisfactorily as screening organisms to date. The new method offers the possibility of developing dosage-response data for interpreting the dynamic relations between microorganisms and antiseptics.

Performance of Paper Machine Wet Felts. II. Further Studies of the Plugging of Felts, D. W. French, C. M. Christensen, and S. J. Buckman

The wet felts of papermaking machines may become plugged or occluded by deposits which accumulate on and adhere to the wool fibers. This often occurs before mechanical wear or microbiological deterioration have much affected felt performance, although it may be associated with some aspects of microbiological activity within the felts.

To determine the degree to which various felts were plugged, the following technique were used: (1) samples of felt were embedded in plastic, sectioned with a microtome, the sections stained and examined microscopically; (2) the amount of time required for a given amount of water to pass through a sample of felt under standardized conditions was determined; (3) the amount of water absorbed by a felt sample of standard size, and the amount retained after passing the wet sample through a wringer under constant pressure were measured. A combination of these methods gives more accurate information than any one of them alone.

A number of techniques were devised to determine the nature and composition of the material causing plugging: (1) plugged felts were extracted with various solvents to obtain resins and similar materials; (2) felt samples were ashed to determine mineral content; (3) samples were blendorized in a Waring blendor to remove deposits from the fibers. These were subsequently separated, and the deposits subjected to various tests to determine their nature. As a result of these tests it was found that the material causing the plugging might consist mainly of resins, mainly of filler material, or mainly of fragments of scales from the outside of the wool fibers. In many felts, the plugging material was a composite of different substances, with considerable variation in make-up from mill to mill according to the type of pulp processed and the kind of paper produced.

Various attempts were made to determine the role played by bacteria in the plugging of felts. These involved culturing of plugged material to determine the number and kinds of bacteria in it, partition chromatography of new and used felts in an attempt to detect bacterial by-products as well as degradation products of the felts, and the inoculation of felt samples with bacteria. It seems unlikely that aggregations of bacteria are solely responsible for large amounts of plugging, but the presence of bacteria may increase the amount of plugging caused by other materials.

Lever Spore Cloud Method for the Evaluation of Antimycotic Properties of Paper and Paperboard, L. J. Vinson

A simple and convenient assay method has been developed for measuring the degree of resistance of antimycotic-treated paper and paperboard toward representative mold strains associated with soap spoilage.

The inoculum comprises a highly sporulated mixture of the test organisms *Aspergillus sydowi*, *Aspergillus versicolor*, and *Penicillium chrysogenum*, isolated from moldy soap. It is prepared by growing the molds on wheat bran under controlled conditions; the mold bran is dried and stored in quart Mason jars which serve as inoculation chambers. A heavy spore cloud is created upon slight agitation of the jar. An amount as low as 25 grams of mold bran can be used for many months as the source of the spore cloud inoculum. This eliminates the need for frequent and tedious preparations of inocula in other assay methods.

One-inch squares of inoculated paper are placed on modified Czapek agar plates and incubated at room temperature. The plates are examined after 7, 14, and 21 days and rated for mold development.

Antimycotic data with the Lever spore cloud method agree well with accelerated storage results for soap wrapped in moldproofed paper.

The importance of protecting soap wrapping material against mold attack cannot be underestimated since appearance of mold on soap in storage is always associated and preceded by the appearance of mold growth on the wrappers.

Factors Affecting Slime Growth, L. A. McKeown

Various factors are studied that affect the quantity of slime deposit in a paper mill system. These factors are of two classes being biological or mechanical in nature. The mechanical factors are the more important since they determine the extent of activity that the biological factors may exert. The influence of the mechanical factors can be corrected for by improved mill design.

Mechanization of Sheet Paper Counting, Charles Stevens

Paper mill finishing processes generally are not only obsolete and outmoded by many years, but represent a most wasteful utilization of factory space, labor, and materials. Finishing labor costs viewed against those of production, reveal figures that urgently demand equipment and revolutionary revision of methods, directed to bring them nearer into balance. Increasingly critical labor conditions, coupled with that of raw material costs alone, further brings finishing cost reduction to the vital point.

Finishing room equipment and methods, even though the most wasteful of the entire mill, are very little different than they were many years ago. The finishing step of sheet paper counting alone, stands out as a most unnecessary and wasteful use of manual labor. Mechanized counting, as a time and production-proved exponent, has, after all these years, become a reality.

"Automatic counting" is the mechanization of sheet paper counting, as a production process, constituting both machines and methods in an operating combination to supplant laborious manual counting of paper, sheet-by-sheet.

Machines, as such, alone can only carry counting mechanization up to a point somewhere short of the complete elimination of manual counting. Mill conditions are fundamentally such that the counting equipment must essentially be cooperatively adapted to the nature of the product as well as to the cutting machines, against that of adapting the preparation of the product and its handling, to automatic counting.

Mechanized counting further serves as a direct means of bringing to the foreground, the unnecessary waste of paper, as well as machine and man-time.

Counting equipments are available, which are readily adaptable to paper mill products, mill machines, and mill conditions.

Mechanized counting equipments, procedures, and operational data, are discussed in a detailed analysis, pointing out, from actual mill operations, how it can be utilized with a high degree of efficiency to accomplish consistent accuracy of count at as high as 50% reductions of manual counting line costs.

Pick Testing of Offset Papers, Gordon C. Wheeler and Robert F. Reed

When paper is printed on a cylinder press, its contact with the printing surface is longer than the actual impression period. Therefore, its rate of separation from the printing surface, and the force required, depend not only on the press speed, but also on tack of the ink, the stiffness of the paper, and stretch or slack in that part of the paper already printed. Since, on sheet-fed presses, the stretch and slack are cumulative the rate and force of ink-film rupture accelerate from front to back of the sheet, resulting in an increasing tendency to pick the paper toward the back edge. However, the picking tendency is reduced somewhat through energy absorption by the paper. In determining pick strength of paper, therefore, it is necessary to simulate closely the conditions that exist in the printing impression.

Picking of paper is defined to include all forms of rupture except the occasional lifting of individual surface fibers usually called linting. The most common form in both uncoated and coated papers is a rupture of internal fiber bonds. Picking stresses are greater in offset than in letterpress printing because of the thinner ink film and tackier inks used, and probably because of the greater conformability of the blanket to the paper surface. Picking stresses are greatest when there is complete ink coverage over relatively large areas.

A simple pick tester has been designed to operate on the offset principle. It consists of a pendulum that carries a spring-loaded hammer and produces an ink impression by impact. Its elements are adjusted to produce approximately the same pressure, period of contact, and rate of separation, as an offset press at normal printing speed. Standard tack-tested inks are used, and both tack and speed, rather than speed alone, are varied.

Pick-test results on 24 papers were found to correlate well with offset press tests using the same series of tack-tested inks, and much better than the wax test or a test using the letterpress principle in which speed alone is varied.

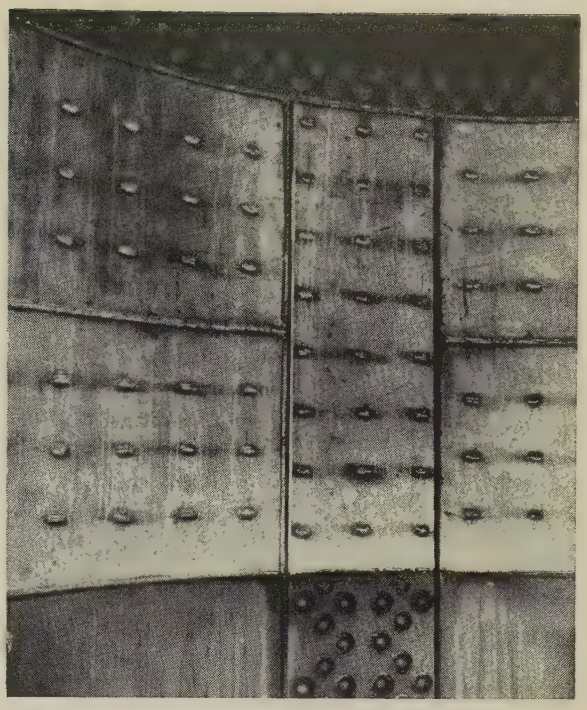
Methods of Increasing the Efficiency of Wet-Strength Resins, J. Vernon Kindall and J. B. Davidson

A study has been made to determine the conditions required for the optimum efficiency of a cationic urea-formaldehyde resin. At the point of addition of the resin, it was found that the wet strength was favored by a low pH and the absence of sizing materials. Following resin addition longer contact time of the resin with the pulp was found to decrease the plugging of the felt with resin. These longer contact times can be obtained practically since the action of the jordan was not found measurably to reduce the wet strength obtained. Reduced maintenance costs can be obtained at a higher pH on the machine though with a reduction in the wet strength.

Problems in Testing Wet-Strength Paper, C. S. Maxwell

The problems of testing wet-strength papers and in reporting and interpreting the results obtained are discussed. The pH of the saturating water is an important factor in determining the rate of hydrolysis of the wet-strength resin with the resulting loss

Inconel Patch Lengthens Digester Life



Corrosion-resisting Inconel patch, as installed in Penobscot Chemical Fibre Co.'s mild steel soda-pulping digester in Great Works, Maine.

Accelerated erosion and corrosion along the liquor line in several mild steel digesters caused trouble at Penobscot Chemical Fibre Co., in Great Works, Maine.

Penobscot decided to try experimental patches of corrosion-resisting metals along the affected upper course of one digester shell. If this plan worked, they knew they'd get longer service life from their digesters at only a fraction of the total replacement costs.

First, small pieces of Inconel® and two other metals were tested for corrosion resistance under operating conditions in the digester. On this basis Inconel was their choice.

Inconel not only showed superior corrosion and erosion resistance, but its coefficient of heat expansion closely matched that of steel — an advantage during the alternate heating and cooling of the production cycle.

The plan decided, the metal tests and selection completed . . . and the job of installation of the Inconel patch got under way.

The Portland Company of Portland, Maine, plug-welded 29″ wide by 6′ long strips in the wearing area of the digester. Test holes were drilled through the shell back of the lining so that if leaks developed the personnel would know about them. The Inconel plates and welding have been inspected by both the mill personnel and insurance company inspectors for signs of corrosion and erosion. To date, the Inconel plates and welding do not show any wear.

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of wet strength. It is pointed out that unbuffered (e.g., distilled) water tends to assume the pH of the paper soaked in it and may give erratic and misleading results, whereas buffered waters maintain their original pH and give much more reproducible results.

Rosin sizing itself imparts some wet strength, but, at the same time, complicates the testing procedure by requiring a longer time for complete saturation—during which time a loss of true wet strength can simultaneously occur. It appears feasible to use a wetting agent on such papers for routine control, provided its effect on the test has been previously established. The problems of correlating off-machine, natural and accelerated aging data are discussed as well as the various methods used in reporting results.

A Mill Control Method for Wet-Strength Papers, A. G. Durgin and W. G. Baker

A method is presented that correlates the wet strength of paper as it leaves the paper machine with the wet strength after natural seasoning.

The type of wet-strength resin used and grade of paper produced affect the test and necessitate the use of different conversion factors. For each resin and grade of paper this factor is obtained experimentally from a quick test and a standard test after seasoning.

The Stress Strain Behavior of Wet-Strength Paper, T. S. Morse, R. T. Mashburn, and W. H. Markwood, Jr.

The Instron tensile tester has been used to measure the energy which wet and dry paper can absorb: (1) when stressed at a continuous rate to the break point, and (2) when cycled several times through stress and relaxation cycles at a maximum load slightly below the "yield" point, then stressed to failure.

Data are presented for laboratory-prepared papers made from unbleached kraft pulp at high freeness. One wet-strength resin only was used in the range of 0 to 5%.

Dry paper containing the resin absorbed more energy than dry paper without resin, but only because the resin increased the ultimate breaking load of the sheet. The resin produced no measurable change in the elongation of the dry paper. Wet paper containing the resin absorbed a great deal more energy than wet paper without resin because both the ultimate breaking stress and the elongation were increased.

A special device is described which made it possible to obtain stress strain data while the test specimen was immersed in water.

Effect of Chip Size in Kraft Pulping, W. J. Nolan and Wilson F. Brown

Slash pine chips, much smaller in cross section than standard mill-size chips, have been pulped and yield data, chemical analysis, and physical strength of resultant pulps are compared to those obtained by pulping regular chips under identical conditions. Chip reduction was obtained mechanically by use of a hammer mill with $^1/_2$-inch expanded metal discharge screen. In one case, dry chips were fed to the hammer mill. In the second instance, chips were steamed 10 minutes at 170 p.s.i.g. in dilute sodium carbonate solution before being fed to the mill. Mechanically treated chips were separated into screen fractions of 4, 6, 8, 10, and 16-mesh. These screen fractions indicate cross-section dimensions at right angles to the grain as all fractions were about as long in grain direction as untreated chips.

These small cross-section chips can be pulped to about 50% screened yield in 1.5 hours as compared to 43.4% in 2.5 hours from regular chips cooked under identical conditions. Pulps from chips hammer-milled without steaming are slightly lower in tear but otherwise as strong as pulps from regular chips. Pulps from chips which had been hammer-milled after presteaming were stronger in tear and fold and about equal in other factors when compared to pulps made from regular chips.

Physical strength values of pulps made from small size chips remain about constant from 4 through 8-mesh; 10-mesh shows a slight decrease and 16-mesh shows a definite drop in strength.

Hammer-milling of dry chips prior to cooking offers good promise to present mill operation. Bulk density is 24% higher than regular chips, yields of screened pulp are 50 instead of 43.4%, and cooking time is reduced by 1.0 hour from the 2.5 hours for regular chips. Shorter cooking times with tolerance of some screenings in pulp offer prospects of even higher yields if hot refining is used.

The application of hammer-milling chips which have been presteamed should be confined to continuous pulping. Bulk density of treated wood is only 77% that of regular chips, chip ends are broomed out, and chips appear somewhat porous, making them well suited for high reaction velocity with minimum degradation.

Studies in Continuous Alkaline Pulping II, High Alpha-Cellulose Pulps from Scrub Oak, W. J. Nolan and W. F. Brown

Further data are presented on the Florida continuous process, involving presteaming and shredding of chips followed by pulping at substantially constant concentration and temperature. The effects of wide ranges of steam pressure and liquor concentration on yield and chemical analysis of oak pulps are tabulated.

A definite relationship between pentosan content of pulps and liquor concentration has been found. Per cent pentosan can be regulated from 9 to 11% at 20 g.p.l. to 2 to 3% at 80 g.p.l. Only minor changes in pentosan content have been observed due to variations in cooking pressures between 115 and 170 p.s.i.g. or variations in cooking time between 10 and 30 minutes. Under presteaming conditions thus far used prior to shredding, the upper limit for pentosan content seems to be in the neighborhood of 12 to 13% instead of the 20 to 22% realized in batch pulping of untreated chips. This is due to the fact that about 23% of the pentosan in the chip is removed by steaming, possibly due to acidity in the center of the chip in spite of the alkaline steaming liquor.

Yield, lignin, and alpha-cellulose content may be very closely controlled by steam pressure, liquor concentration, and time. For example, a pulp of 44% yield and 2.0% lignin content can be produced in 10 minutes' time of contact with liquor of 35 g.p.l. with a steam pressure of 170 p.s.i.g. Pulp of about the same analysis can be obtained in 20 minutes with 50 g.p.l. liquor and 115 p.s.i.g. Alpha-cellulose content is 93 to 95%.

Alpha-cellulose content may be regulated between 85 and 95% depending on conditions used. It is estimated that 90% of the alpha-cellulose available in the wood (determined by modification of TAPPI Standard T 9 m) is retained in the pulp.

Permanganate numbers covering a range from 9.0 to 33 are tabulated for some of the pulps. No quantitative relationship between permanganate number and lignin content of pulps could be found.

No data on viscosity, D.P. number, or alkali purification of pulps are presented in this study.

The Barking of Turkey Oak, R. L. Harvin, W. J. Nolan, and W. F. Brown

Information on the barking of oaks, particularly turkey oak, is necessary if the new developments and processes leading to the use of such wood are to become a reality. There is very little information available in the literature on the barking of oak. The general problem of barking of oak was undertaken to obtain data on the several methods of barking in order to determine which method might be commercially satisfactory. The results reported in this paper are on two types of barking: (1) drum barking as usually practiced in the South and (2) a method which consists of chipping the log with the bark still on it, screening and then separating the bark from the chips by air-flotation equipment. In addition data are reported on screening of the mixture of bark and chips.

The data obtained on the barking of freshly cut oak wood in a drum barker show that it requires approximately twice as long to bark the oak when compared to the normal barking time for pine. The results show that, when sufficient time is allowed for barking, the oak bolts which would be sent to the chipper would have less than 1% of bark. The oak used in these trials was cut in the latter part of November. Half of the logs cut at that time are now in storage and will be barked after 2 months' time to test the effect of storage on the efficiency of barking of stored logs in a drum barker.

The data presented on screening a mixture of bark and chips show that 90% of the material is retained on $^1/_4$-mesh screen. The percentage of bark in this material was approximately 24.4% showing that as a means of eliminating bark from chipped oak wood screening alone would not be satisfactory. The material retained on $^3/_4$-inch mesh contained 3.9% bark and this fraction represented 48.4% of the original mixture.

The data obtained using the air separation method show that a product containing 95% wood and 5% bark can be obtained under the conditions of the experiments. The material airfloated was that portion which passed through $^3/_4$-inch mesh and was retained on $^1/_4$-inch mesh. This represented 42.3% of the original mixture.

Esterification of Tall Oil with Glycerine, Robert S. Aries and Melvin Wolkstein

Whole tall oil was esterified with glycerine at different temperatures for the purpose of obtaining the rates of esterification of both the fatty acids and rosin acids. Some distilled tall oils with varying rosin acid content were also esterified to find the effect of the rosin acids on the esterification. Several catalysts were evaluated for their effectiveness. The effect of temperature and catalyst on the possible decarboxylation of the rosin acids was also studied.

Also included are methods for the determination of acid numbers, rosin acid numbers, and saponification numbers of tall oil esters.

Glycerine was chosen for these studies because it has been used to such a great extent in this field and for its similarity to many other polyhydric alcohols.

It was found that the optimum temperature for the esterification of tall oil with glycerol is at about 275°C. Catalysts may quicken the reaction at the start but offer no advantage where low

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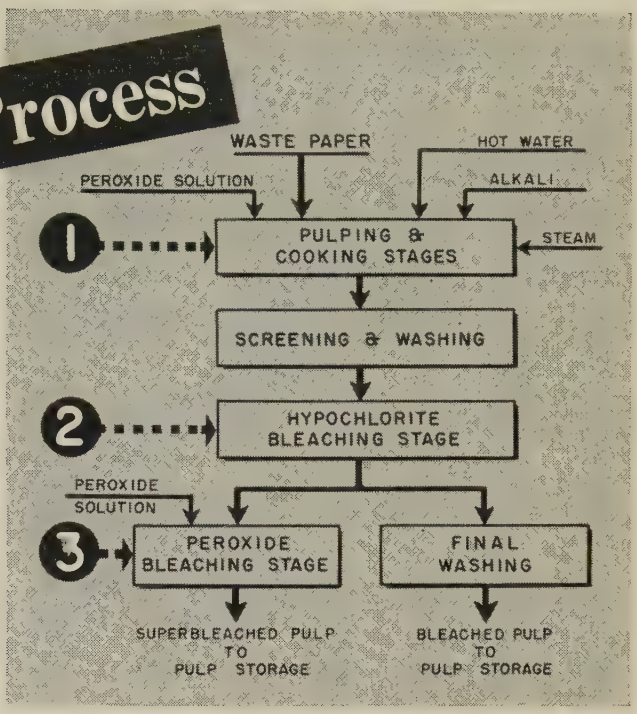

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acid numbers (around 5) are desired. The fatty acids are almost completely esterified before the rosin acid esterification becomes appreciable. Very little reaction occurs with the rosin acids until temperatures of about 190 to 200°C. are reached. The high temperature (275°) is required to esterify the rosin acids to a low acid number. The amount of rosin acids in the tall oil has very little effect on the rate of esterification. The extent of decarboxylation of the tall oil does not become appreciable until temperatures of over 300°C. are reached.

Uniform Cooking by Continuous Kraft Semichemical Process, A. P. Yundt

Batch semichemical pulping permits time for diffusion of the liquor into the chip and cooking can be uniform. However the system is not amenable to primary refining at cooking temperature. Conventional continuous semichemical pulping does not allow time for diffusion and the outsides of chips (or chip fragments after a screw plug chip feed) are overcooked leaving undercooked centers. This is easily demonstrated by the phloroglucinol groundwood reagent. Shives of all such commercial pulps stain strongly red.

A commercial plant is described wherein the chips are presteamed to drive out air, soaked 4 hours in hot dilute kraft liquor at atmospheric pressure, drained, and the drained chips are introduced into conventional continuous semichemical pulping equipment by use of a rotary feed valve. The uniformity of cooking is excellent and, at 5 horsepower-days per ton, refining is superior to comparable yield pulps by conventional means using 10 to 13 horsepower-days per ton. Properly softened chips can be defibered at cooking temperature with little breakage or other fiber damage. Such a system seems ideally adapted to the production of the shive-free long-fibered pulps required for high-grade bleached neutral sulphite semichemical pulps.

Presoaking is best done at elevated temperature because of decreased ion hydration, viscosity, and fiber swelling, and increased average thermal velocities.

Semichemical Pulping Using Kraft Liquor, E. M. Leavitt

The plant was built with maximum flexibility to produce hardwood semichemical pulps or modified kraft pulps. The main features are:

1. Concentrated control of process on operating floor.
2. Yields 0.95 to 1 cord of wood per ton of pulp.
3. Low chemical costs due to use and recovery of kraft liquors.
4. Quality is indicated as being equivalent to that of neutral sulphite semichemical.
5. Liquor recovery at about 8% solids is returned to kraft black liquor recovery system.
6. Losses to sewer are about 5 to 10 pounds of salt cake per ton.

Some Observations on Sulphate Turpentine Recovery, M. R. Dusenbury and J. E. Reese

Recovery of crude sulphate turpentine is becoming of more economic importance as a stable market has developed for this material. Southern pulp mills recover up to 4 gallons per ton and northern mills recover somewhat less. Some of the important factors in the design of recovery units are discussed. The design of an automatic decanting tank for separation of crude sulphate turpentine and steam condensate is given which minimizes trouble with emulsion formation. Corrosion of steel by crude sulphate turpentine is caused by the sulphur compounds which are present, and it is quite severe, particularly in the vapor phase and at a pH below 8. A simple method of preventing this corrosion has been found which consists of adding 0.25 of 28% aqueous ammonium hydroxide to the crude sulphate turpentine. This method has been used to prevent corrosion in tank cars and storage tanks.

A Volumetric Gas Analysis Method for Measuring Simultaneously Oxygen and Carbon Dioxide Permeabilities, Arthur H. Landrock and Bernard E. Proctor

A method has been developed for measuring the permeabilities of oxygen and carbon dioxide simultaneously by utilizing Dalton's law of partial pressures, which states that in mixtures of gases each gas behaves independently of other gases present and the total pressure is the sum of the partial pressures. Each gas in permeating a sheet will, therefore, permeate according to its partial pressure differential across the sheet.

The application of Dalton's law to the measurement of gas permeability is not entirely new. Platenius in 1946 developed a simple form of apparatus for this measurement also based on Dalton's law. Platenius, however, was interested only in oxygen permeability and its relation to the respiration of fresh produce.

In the method developed and studied at the Department of Food Technology at the Massachusetts Institute of Technology, a large metal cell is designed in such a way that it provides a lower static chamber of known volume (about 5850 ml.) and an upper sweeping chamber of about 1500 ml. The test sheet is mounted between these two chambers and, with the help of rubber gaskets, is held rigidly by a specially designed system of clamps.

Nitrogen is swept through the large chamber until it replaces all or almost all the air present. The actual amount of oxygen and carbon dioxide present is determined accurately with the aid of an Orsat gas analysis unit. To provide high sensitivity, a buret calibrated in units of 0.05 ml. in its lower portion is used.

A mixture of about 80% oxygen and 20% carbon dioxide is then swept through the top chamber at a slow rate, while the lower chamber is sealed off. The 4:1 ratio of oxygen to carbon dioxide approximately compensates for their differences in permeability through most sheets. Therefore, approximately equal amounts of the two gases permeate the sheet under test conditions. The pressure on both sides of the sheet is atmospheric.

Test periods range from several hours to several days, depending on the permeability of the sheet. At the end of the test, a gas analysis is again made of the atmosphere in the lower chamber. A simple equation permits the calculation of the oxygen and carbon dioxide permeabilities quickly.

A large number of plastic films and laminates were studied, and the results were as good as could be expected with gas permeability measurements without temperature control. The effect of relative humidity was studied on some films, particularly the cellophanes. The apparatus readily lends itself to humidity control.

This method gives results that should closely approximate actual packaging conditions, for the total pressure on both sides of the film is always essentially atmospheric. Because it is necessary to build up only very small amounts of test gases on the nitrogen side of the sheet before they can be accurately measured, the driving force across the sheet remains essentially constant.

Development of Design Data for Corrugated Fiberboard Shipping Containers, K. Q. Kellicutt and E. F. Landt

From an early basic study at Forest Products Laboratory and a current investigation it had been concluded that basic design criteria for corrugated fiberboard containers could be developed from simple tests of the component sheets. In the early stages of the investigations the modulus of elasticity of paperboards, as determined from a tension test was found to correlate with strength properties of the built-up corrugated board. However, the tension test was discarded as being too precise for general use. After further study it was found that either the ring-crush test or the strip-column test of paperboard could be used for design purposes.

As paperboard is a nonisotropic material it was recognized that a formula applicable to fiberboard with the machine direction parallel to the applied load might not be applicable to fiberboard with the load applied perpendicular to the machine direction of the fourdrinier or cylinder paperboards. With the recognized characteristics as a guide, a basic formula was evolved paralleling data developed at the Forest Products Laboratory for applying the thin plate theory of mechanics to the design of panels of plywood. Initially the mathematical relationship involved in the bending and crushing of each of the four walls of a fiberboard box was established for the tube.

By use of the formula and test values of the component paperboard sheets the compressive strength of tubes in various sizes, made from corrugated board, could be predicted with reasonable accuracy. The tube, having square cut edges, represents the optimum that can be obtained with any given corrugated board. Hence, to use the formula for design purposes the relationship between the tube and box was established for making the predictions directly for a box.

To determine what portion of the compression test value a box can be expected to support for specific periods of time in storage, long time-loading tests were made. The relationship between the machine compression test value of boxes, the magnitude of the dead load of storage, and the duration of loading have been indicated by these tests.

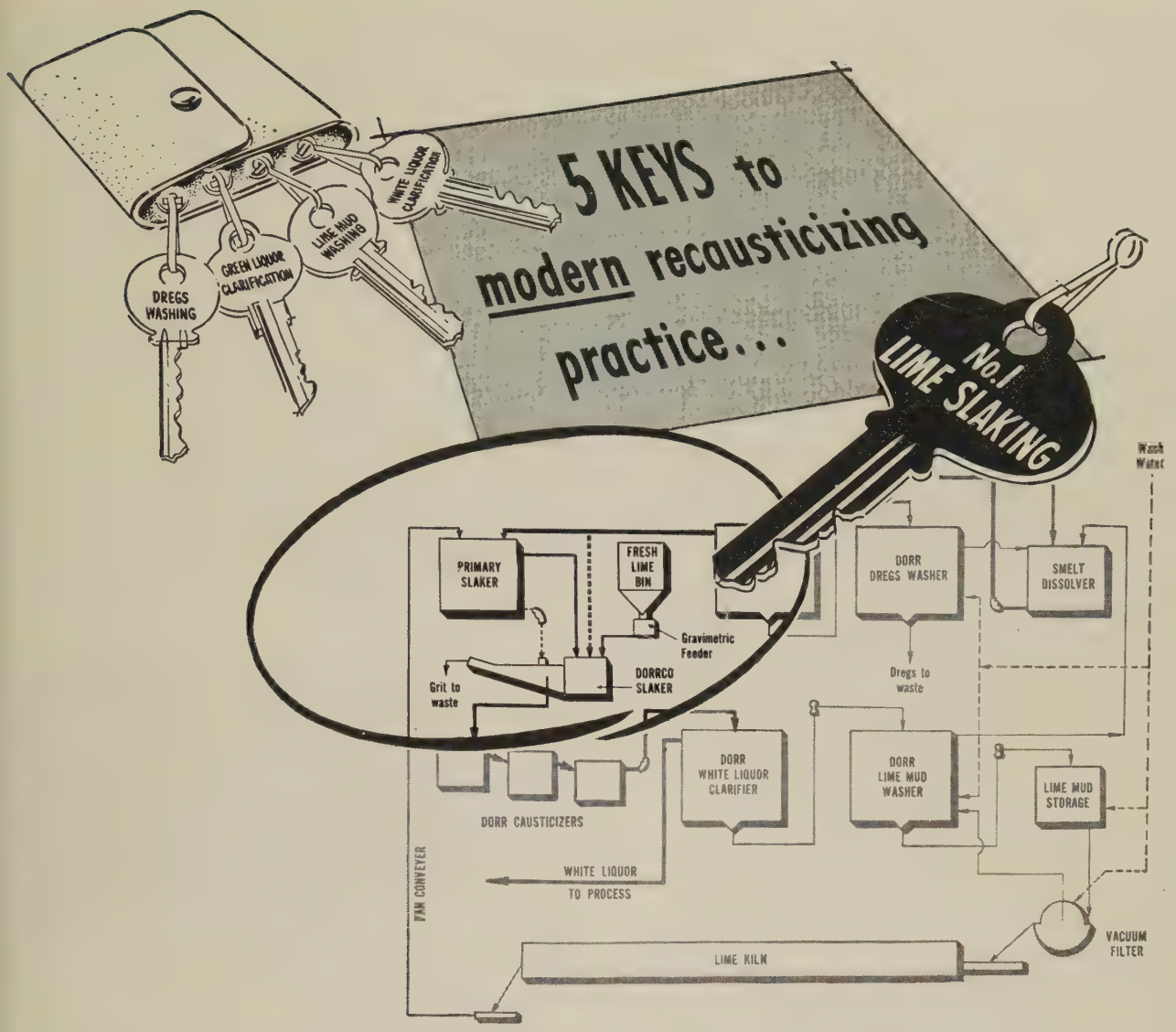
From compression tests of boxes made in various atmospheres the relationship of compressive strength of boxes to moisture content of the fiberboard was derived. From the known compressive strength of a box having a specific moisture content, the compressive strength can be interpreted in terms of other moisture contents of the fiberboard.

Some Observations on the Kinetic Coefficient of Friction of Paper, Geoffrey Broughton and Joan L. Gregg

Little systematic work on the kinetic coefficient of friction of paper appears to have been done. In the present work, the friction meter developed by E. C. Dreby has been adapted to paper.

The coefficient of friction was found to increase with increasing relative humidity, beating, rosin content, and filler content. It decreased on medium calendering, with addition of fatty acids and paraffin. Different furnishes showed friction coefficients varying considerably, the cross direction also showed a higher coefficient than did the machine direction.

Gloss and surface roughness measurements were also made upon some of the papers studied.



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Semichemical Process Flow Sheets, J. E. Sapp

The expansion of semichemical pulping in recent years is due primarily to the increased demand for corrugating board, insulating board, etc., but these pulps are also suitable for many other uses. Other advantages such as high yields, low chemical consumption, the diversity in chemicals which may be satisfactorily used, etc., make the continued expansion in semichemical pulping seem assured. The two major processes at present are the sulphate and neutral sulphite, though a number of others such as the neutral ammonium sulphite and the cold soda show considerable promise. While practically all semichemical processes at the present time use disk refiners to complete the defibering after the initial chemical treatment, there are various ways in which the pulping, washing, and defibering may be carried out. Some of the most common of these are shown in flow diagrams and their advantages and disadvantages briefly discussed.

A Design Basis for Ammonia-Base Sulphite Raw Acid Towers
Roy P. Whitney and S. T. Han

Current interest in the ammonia-base sulphite process has directed attention to the preparation of the raw cooking acid. Since the ammonia-base system has certain unique features, with respect to the other bases. the acid-making equipment must be designed and must function accordingly.

The factors which are important in the design of a raw-acid tower are considered in some detail, and an accumulation of the best available design data for this system is presented. These data are derived in part from the literature, and in part from previously unpublished work.

The data and techniques presented are then used in an illustrative problem involving a raw-acid tower design for a set of typical operating conditions. The conversion of existing equipment to ammonia-base operation is also considered.

Semichemical Pulps: Strength-Sheet Density Studies, Daniel O. Adams and James L. Tennant, Jr.

Four soda and four kraft semichemical pulps were prepared from New England hardwoods in a laboratory Asplund-type defibrator. Yields were from 63 to 84.8% on an oven-dry basis. These pulps were evaluated for use in flooring and roofing felts by laboratory beater studies. Hand sheets were made at a base weight of 40 pounds per 480 square feet, a common saturating felt weight.

When tear, tensile, and burst of these sheets are plotted against freeness, increasing strength with increased delignification is apparent. However, when the same strength properties are plotted against sheet density, the situation is more complex. The strengths of the unbeaten pulps are uniformly low, and their densities increase with decreasing yield. With beating, both sheet density and sheet strength increase. The slope of the strength versus density curve is generally greater as the yield is decreased. Thus the strength versus density curves at the various yields, cross each other. There is a definite density range within which 5% NaOH gives maximum strength. In another range, 2.5% NaOH gives maximum strength, etc.

At any given sheet density there appears to be a particular quantity of chemical which gives maximum strength sheets. More or less chemical used in cooking results in weaker pulps at the given sheet density.

Semichemical Pulping—A Process Study, C. W. Converse

The semichemical pulping processes have expanded at a rapid rate during the past six years. Compelling economic forces have brought about this expansion. Another fact now becoming important is the development of bleached semichemical pulp. Semichemical pulp has characteristics which make it very attractive to use in many grades of paper and board and it is today used in grades from 9-point corrugating board to bond paper. Present-day pulp has some limitations but these are being eliminated by various methods for modification of the pulp characteristics. Fully bleached pulp in a yield of 60% and higher is a commercial accomplishment. The burst, tear, tensile, and tear strengths of bleached semichemical pulp are higher than those of bleached softwood sulphite.

Three commercial semichemical processes are described: neutral sulphite, sulphate, and cold caustic. Of these only the neutral sulphite process is used to produce bleached pulps. Both rotary and vertical digesters are used and also continuous digesters. Movement of the cooked chips to the refiner may be by mechanical methods or by pumping. Refining, the reduction of the chips to pulp, is the heart of the process and is always accomplished in disk refiners. The advantages of one versus two-stage refining are discussed. The pulp may be washed and screened after which it goes to the paper or board mill.

Based on this information, an effort is made to select the ideal process design for each type of digester and to select the ideal digester for the particular requirements.

The neutral sulphite process is quite corrosive and stainless steel should be used in contact with unwashed stock, especially when hot. Tramp material protection for the refiners is highly important.

Improved Diffuser Washing—Markila-Brax Strainers and Angle Iron Supports, K. F. Gothner and H. T. Robson

In an effort to increase the washing capacity of the 40 diffusers at the Union Bag and Paper Corp., Savannah, Ga., two modifications of conventional diffuser design were installed and operated on an experimental basis. The first of these was an invention of Finnish origin known as Markila-Brax strainers. These consist of vertical, leaf-shaped strainers extending from the walls of the diffuser toward the center, mounted with screens on both sides. This installation was also equipped with a Sandberg valve to provide automatic dumping. The second modification consisted of crossed angle irons mounted about 5 feet above the diffuser bottom.

The first series of washes was made on 12 by 29-foot diffusers (No. 1 unit) and the second on 13 by 27-foot diffusers (No. 2 unit). The stock was southern pine kraft cooked for 2 hours to a permanganate number of about 27. The diffusers operated under a pressure of about 24 p.s.i. The pulp washed by the conventional diffusers and either of the two modifications was equally clean.

On No. 1 unit the volume of underflow liquor was measured by means of orifice meters and found to be about 11% less from the Markila-Brax diffuser. When the washes on No. 2 unit were made, the underflow liquor was collected in receiving tanks. In this case it was found that the Markila-Brax strainers increased underflow dilution about 6%. There is perhaps no significant change in underflow dilution when a diffuser is modified with either invention.

On No. 1 unit the Markila-Brax strainers reduced the average washing time from 8 hours 35 minutes to 3 hours 35 minutes, a reduction of 58%. On No. 2, however, this remarkable result could not be duplicated. Here the diffusers are 1 foot greater in diameter and wash the same weight of stock, therefore the pressure on the bottoms is less, thus offering less chance for improvement with the strainers. In this case the Markila-Brax strainers reduced washing time 29%. The same pattern was followed by the washes with the diffusers equipped with angle irons, which permitted a reduction of washing time on No. 1 unit of 18%, and on No. 2 unit, 13%.

It is not practicable to dump a Markila-Brax diffuser through the conventional door because pulp tends to bridge across between the strainers and above them. However, it was found that the Sandberg valve could dump the Markila-Brax diffuser in 22 minutes which was about the average dumping time for the regular diffuser and the angle iron diffuser. Assuming 40 more minutes to make up the total cycle time, it was found that the capacity of No. 1 unit could be raised 108% by the Markila-Brax strainers, or 22% by the angle irons. The capacity of No. 2 unit could be increased 33% by the Markila-Brax strainers or 12% by angle irons.

Straw Pulp-Woodpulp Blends for Various Types of Papers, S. I. Aronovsky, A. J. Ernst, R. J. Seidl, and R. M. Kingsbury

Illinois-combined wheat straw was pulped by the mechanochemical process, bleached, and blended with Lake States wood pulps to produce typical magazine, book, newsprint, bond, bag, waxing, and greaseproof papers on an experimental fourdrinier paper machine. Control runs were made using wood pulps only. The inclusion of straw pulp in these paper furnishes resulted in improved formation, bursting and tensile strength, and folding endurance. The tearing resistance of the straw-containing papers was somewhat lower than that of the controls, but the reduction in tear was relatively small. It is evident from these preliminary data that straw pulp could be used to good advantage in improving many types of specialty papers.

Fundamentals of Lithography for Paper Makers, R. F. Reed

Lithography was invented about the year 1800. It employs a printing surface that is neither raised nor depressed. The areas that are to print are made ink receptive, and the nonprinting areas are kept ink repellent by a film of water. Lithography was originally done from stones, but is now done almost entirely from thin metal plates on the offset press.

Simple black and white lithography is often called planography or photo-offset. But the principal field of lithography is color printing, the highest form of which is four-color process. Almost all printing plates are now made photographically, usually on sheet zinc or aluminum. Three types are in general use, and are known as surface or albumin plates, deep-etch plates, and bimetallic plates. Which of these is used depends primarily on whether the runs are short, medium, or long, respectively.

The offset press unit consists of three cylinders: a plate clinder, a blanket cylinder, and an impression cylinder. In printing, the plate is first dampened with water and then inked, after which the ink image is transferred to the rubber offset blanket that impresses it on the paper. Offset presses are both sheet-fed and roll-fed, the latter running at speeds up to 900 f.p.m. Offset ink must be concentrated in color and resistant to emulsification in water. The ink pigments must be highly insoluble. The inks are gener-

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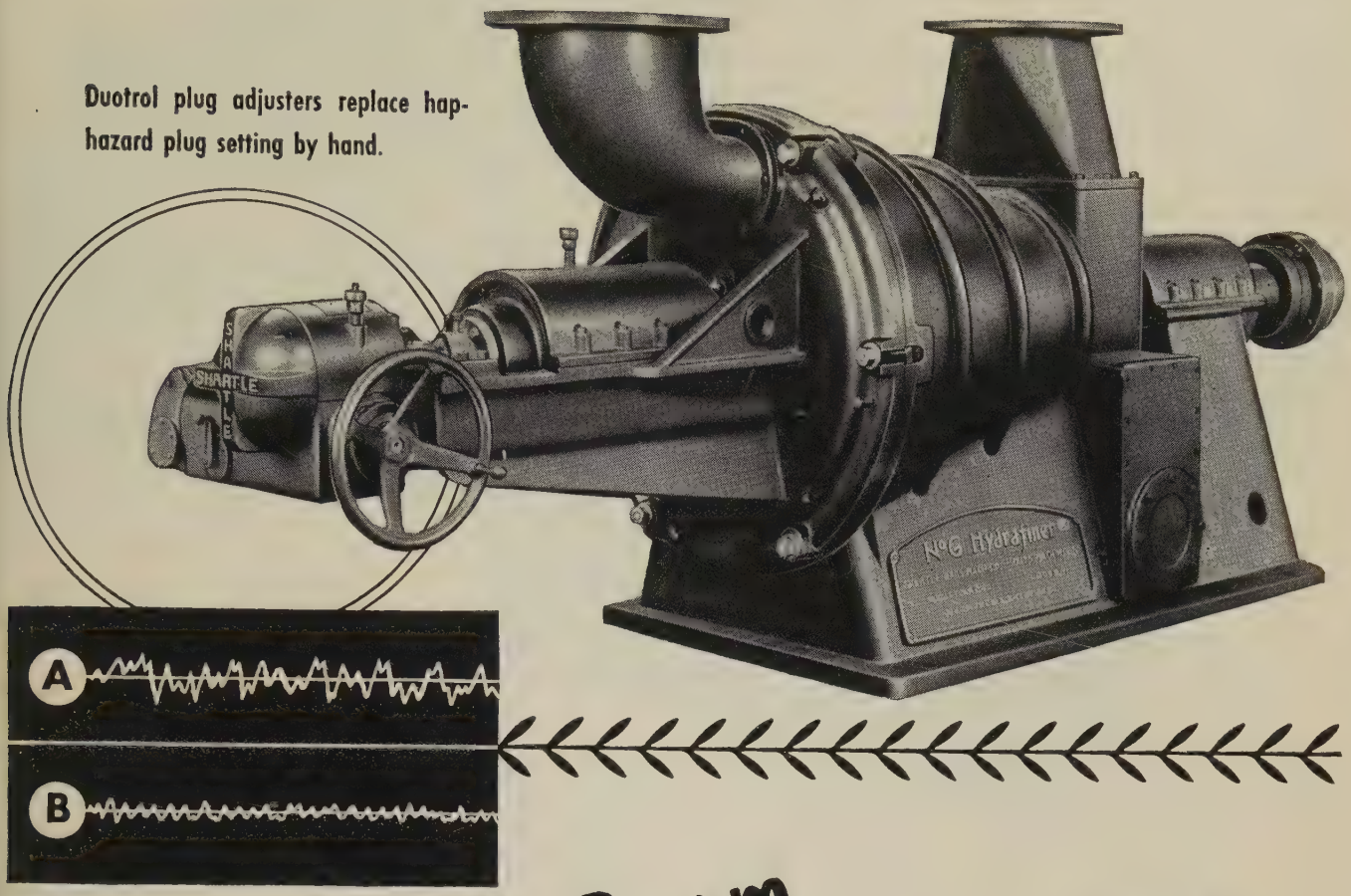

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ally of the drying-oil type, although heat-set inks are being used increasingly on web presses.

The offset press made possible halftone printing on rough-surfaced papers. Experience has shown, however, that the best color values are obtained on smooth-surfaced papers, and the use of coated offset papers has steadily increased. The versatility of the offset press has made possible a wide variety of printing, and the lower cost of offset plates makes the process particularly adapted to color.

Offset lithography places some special and somewhat more severe requirements on paper than letterpress printing. Because of the uniform squeeze impression, paper must be flat. Wavy or tight-edged paper causes misregister and wrinkling. If roll paper dries out, the edges shrink, and this results in web breaks on the press. Offset paper should be free from lint and dust, as these transfer to the blanket and plate and necessitate frequent press washups. Since a thinner ink film is applied, the pull on the paper surface is greater, and it should have a somewhat higher pick resistance than letterpress paper. Coated offset paper should have a greater degree of moisture resistance to prevent the transfer of coating pigment to the moist offset blanket.

Curl in Paper, A. S. Erspamer and W. D. Rice

Much has been said and written about the common defect, paper curl, and a literature review can do much toward clarifying the problem. The authors of this paper present a summation of known facts and observations about curl and related effects, hoping thereby to stimulate a more concerted attack upon the problem.

The characteristics of grain, two-sidedness, and fiber expansion-contraction assume basic roles in causing or affording curl in paper. Types of curl are defined and described as moisture or humidity, inherent, and structural. A review of the papermaking variables influencing curl is presented to complete the coverage of the problem as related to manufacture.

The Determination of Copper in Wood Pulp with Tetraethylenepentamine, R. M. Kingsbury and C. L. Lake

A simple and rapid method is described for colorimetric determination of copper in cellulosic material. The sample of material is digested with nitric, sulphuric, and perchloric acids, is neutralized and filtered if necessary, and a blue complex is developed with tetraethylenepentamine. The amount of copper is determined by comparing the transmittancy of the solution to that of standard copper solutions by using a photometer with a filter having maximum transmission at 595 to 640 mmu. The sensitivity, when a 10-gram sample is used, is about 1 p.p.m. as copper.

Determination of Pentosans in Highly Purified Wood Pulp, Edgar D. Smith, Louis F. Pagel, and L. N. Rogers

All methods used for pentosan determinations depend upon the formation of furfural when pentosans are boiled with dilute mineral acids, and a variety of methods have been proposed in the literature for analyzing the furfural so produced. None of these methods was designed for use on pulps having 1% or less pentosans, however, and the methods are generally too insensitive to afford reasonable precision when applied to such pulps.

In this work, a search was made for more sensitive analysis methods for furfural and its derivatives. The colorimetric method of Adams and Castagne using aniline acetate was found to be satisfactorily sensitive and to be specific for furfural in the pentosan distillates, but it was not considered suitable for routine work. Two new methods were developed, one a polarographic method and the other an ultraviolet absorption technique, both of which measured total aldehyde and were satisfactory from the standpoint of sensitivity. The ultraviolet method, however, involved only a single light absorption measurement of a diluted aliquot of the acid distillates and was therefore the easiest to use in addition to being the most sensitive and precise of all the methods tested.

The results of the new ultraviolet absorption analysis for furfural plus hydroxymethyl furfural were compared with those obtained on the same pentosan distillates by the TAPPI bromate titration procedure. It was shown statistically that the two methods measured equal quantities of material and that the results of the TAPPI procedure could be calculated from those of the light absorption analysis *within* the limits of error of the TAPPI analysis method. The standard deviation of the TAPPI method in the range 1 to 3% pentosans was found to be ±0.26% pentosans, while that of the ultraviolet method in this same range was only ±0.05% pentosans.

It was pointed out that the differences between the results of the ultraviolet method and those of the aniline acetate method, as applied to typical pulp distillates, should provide a much better measure of the hydroxymethyl furfural in these distillates than has been heretofore obtainable.

The Colorimetric Determination of Pentosans in Highly Refined Pulp, A. S. O'Brien and T. L. Davis

The pentosan content of highly refined pulps can be analyzed with high precision using the aniline acetic acid colorimetric method. The pentosans of the pulp are converted to furfural by a distillation with acid in the ordinary manner. The colorimetric procedure is specific for furfural. Methyl or hydroxymethylfurfural do not interfere in the method.

The color development is highly empirical, but if several variables are carefully controlled reproducible values can be obtained. The color is sufficiently stable for successful application in the laboratory.

The distillation step of the procedure is the same, in general, as that employed in the volumetric or gravimetric methods. The importance of several distillation variables was investigated using highly refined pulps. The size of pulp sample used was a slightly significant variable.

The rate of distillation is of minor importance, but should not vary between extreme limits. The hydrochloric acid in the distilling flask quickly approaches the constant boiling composition 20.3% as the distillation proceeds, in spite of the fact that 12% acid is being constantly added. The concentration of the acid and the temperature of the pulp slurry are nearly the same during most of the distillation regardless of the strength of the acid being added in the range 12 to 20%. Based on the pentosan results the strength of the acid used in the distillation proved to be of slight significance in the range of 12 to 20%.

The total volume of distillate collected is a highly significant variable. Furfural continues to be formed from highly refined pulps after the first 360 ml. has been removed. In fact furfural is still being formed in measurable amounts in the seventh 360-ml. portion of distillate. The amount of methyl or hydroxymethylfurfural is small compared with the quantity of furfural, and drops off rapidly as the distillation proceeds through successive 360-ml. portions.

The colorimetric method was applied to several highly refined wood pulps and cotton linters. The precision of the method is good. A pentosan value of 0.12% was obtained for a treated cotton linters sample. Several materials falling in the range 0.10 to 0.60% pentosan were consistently differentiated.

On Sampling of Wood Pulp for Moisture, A. P. Bellinghausen

This work is a response to two questions: (1) by taking the minimum number of sample bales or rolls specified in T 210 m from cars of pulp, is it possible to estimate the air-dry weight with 1% precision with reasonable assurance, and (2) if more than the minimum specified number is necessary, is a multiple coring technique likely to give 1% precision at lower cost than the specified single coring method taking the same number of cores. It was necessary to limit the experimental work to 80 to 85% air-dry sulphate in bales and 85 to 90% air-dry sulphite in rolls. The techniques of Tanner and Cameron applied to sampling of baled wool for clean content were used.

Within the limits of the experimental work, it is concluded (1) that minimum sample sizes given in T 210 m are insufficient to give 95% assurance that the air-dry weight will be estimated within 1% by two reliable testing agencies. It is also concluded (2) that under the conditions of variability within and between rolls and of costs of taking the sample rolls and of coring them, there is a cost advantage to taking more than one core per roll under a sampling plan designed to achieve the specified precision.

In order to apply the theory of sampling of Deming, Tanner, and Cameron, and others to the problem of setting up sampling schedules for wood pulp, further work along the lines suggested remains to be done. Estimates of variance between and within bales, bundles, rolls, or skids, across the several ranges of air-dry test used in practice, would have to be made, tested for stability in time, and refined by repetition. These estimates are the raw materials upon which the agencies should work in developing more realistic and more workable standards for determination of moisture of wood pulp for the industry.

Routine Determination of Lignin in Semichemical Pulps by a Modified Tingle Procedure, B. L. Browning, L. O. Bublitz, Paul E. Trout, P. A. Franckowiak, and J. L. Ham

Direct methods of lignin determination are too time-consuming to be practical for mill control use. For this reason, most routine "hardness" or bleachability tests employ indirect methods. The most widely used of these, the permanganate number, was shown to be inapplicable to semichemical pulps. Inability of the permanganate ion to penetrate the fiber bundles and shives in the pulp resulted in permanganate numbers that did not correlate with the lignin content of the pulp. It was found that treatment of the pulp sample with a 9:1 mixture of hydrochloric and sulphuric acids (as employed in the Tingle bromine absorption method) swelled and partially dissolved the cellulose, thus rendering the lignin more accessible. Subsequent determination of the lignin by hypochlorite oxidation afforded a bleachability test which rivaled the permanganate method in speed and simplicity. Good linear correlation between TAPPI lignin content and chlorine consumed was obtained for neutral sulphite semichemical aspen pulps which had lignin contents ranging from 12 to 17%.

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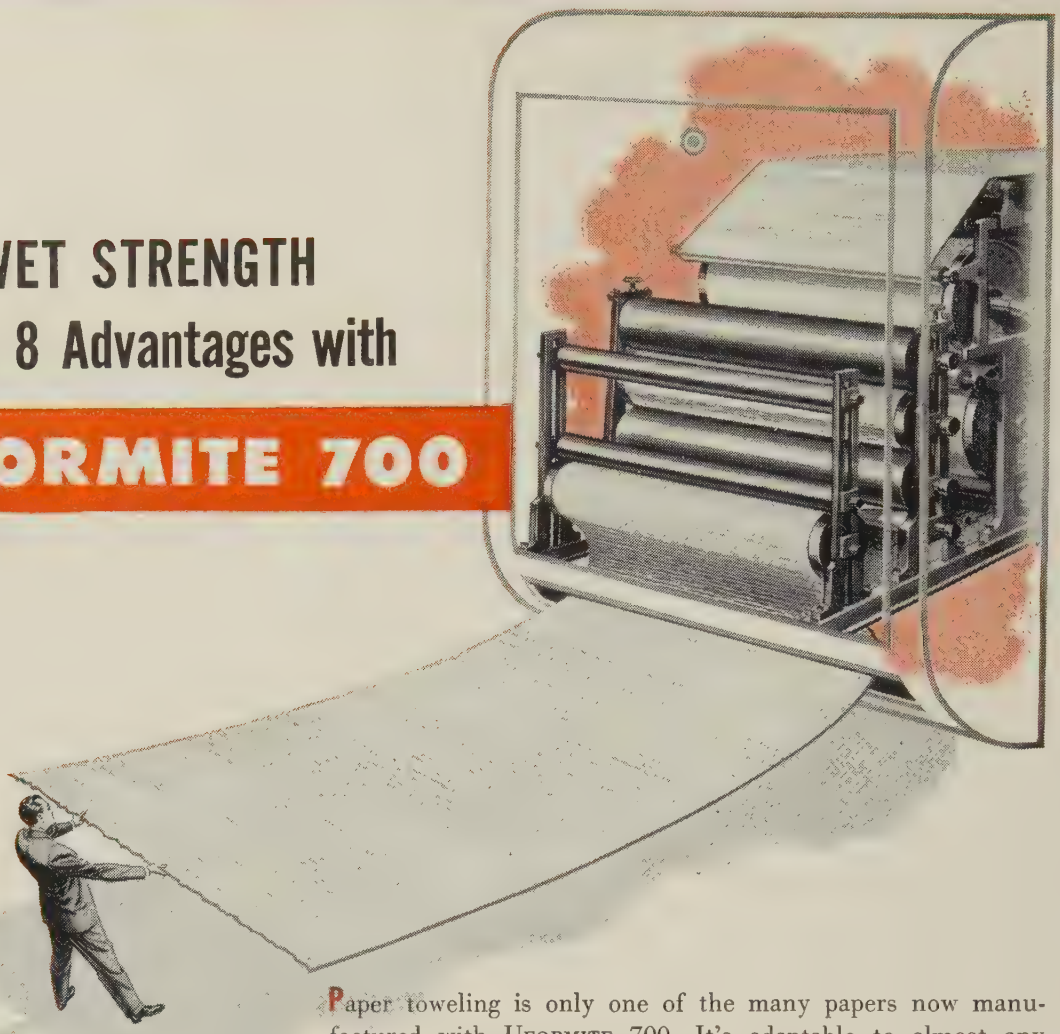

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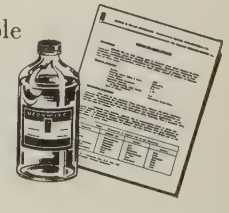

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Combustion Gas Turbine Applications in the Paper Mill

W. B. WILSON and W. C. BLOOMQUIST

The gas turbine can produce substantially more by-product power as the process steam turbine in most applications. It is a simple, self-contained prime mover consisting of a compressor, combustion equipment for burning the fuel, and the turbine. The units are available in three different types which are described briefly. A summary is also given of some of the ways these gas-turbine units can be applied to supply mill requirements for steam and electric power. When required, steam flow from the exhaust-heat recovery boilers can be increased by supplementary fuel firing. Therefore, the gas turbine can be applied where the ratio of kilowatts to process steam is higher than the upper limit of the noncondensing steam plant but lower than the gas turbine operating with exhaust-heat recovery boilers alone. From available data it is estimated that the cost of a new gas-turbine plant is approximately three-fourths that of a comparable steam plant.

Paper mills usually find it economical or necessary to generate a part, and in some cases all, of their electric power requirements because of the large usage of steam as well as electric power.

The paper industry has taken advantage of the economic savings in fuel by generating by-product power from process steam in condensing automatic-extraction, noncondensing, and noncondensing-automatic-extraction turbines developed especially for this service. The power engineer now has an additional tool—the combustion gas turbine—which can likewise be used to supply the mill requirements for steam and electric power at high power-plant cycle efficiency.

In recent years, the electric power requirements have increased much more rapidly than the steam. Because of this fact, mills with a good heat balance a few years ago now find that they must supplement their by-product power generation with "condensing" power or purchased power. In other words, the mills' requirements for power have increased beyond that available as by-product power from process steam using the steam cycle alone. This is evidenced by the trend to higher initial steam conditions for noncondensing and automatic-extraction steam turbines.

The gas turbine can produce substantially more by-product power—two to four times as much as the process steam turbine—in most applications as shown in Fig. 1. Combustion gas turbines with exhaust-heat recovery boilers can supply approximately 10,000 kw. per 100,000 pounds per hour steam flow and at an over-all power-plant cycle efficiency of approximately 70%. This is comparable to the high efficiency noncondensing steam turbine cycle.

Steam power-plant cycle efficiency is highest and the combined cost of steam and power is lowest when the entire electric power requirements can be generated as by-product power using noncondensing or extraction-type steam turbines or gas turbines with exhaust-heat recovery to supply the steam required for process. The power-plant cycle efficiency decreases and the combined steam and power costs increase when it becomes necessary to generate condensing power. The extra kilowatts available from the gas-turbine cycle can minimize the condensing steam power required and improve the over-all power-plant efficiency.

Efficiency is mentioned because the cost of steam and power is a sizable item (10 to 20%) in the over-all cost of the paper mill's product. Therefore, a gain of a few per cent in power-plant cycle efficiency could mean an attractive increase in the profit of the over-all mill operation. Because power-plant cycle efficiency is so important, the paper mill power engineer will certainly be interested in the gas turbine for many applications.

Other gas-turbine cycle arrangements can be used to further improve the over-all power-plant cycle efficiency in many cases. Before going into the details of these gas-turbine applications, the gas turbine itself is described briefly.

COMBUSTION GAS TURBINES

The combustion gas turbine is a very simple, self-contained prime mover and, based on experience to date, it is expected that the gas turbine will compare very favorably with other prime movers from the standpoint of maintenance. The simplicity, space requirements, and first costs are also points in its favor.

A simple open-cycle combustion gas turbine is shown diagrammatically in Fig. 2. It includes the compressor, combustion equipment for the burning of fuel, and the turbine. Atmospheric air is compressed in the compressor and then passes into the combustion chambers. In the combustion chambers fuel is mixed with air required for combustion and also with excess air required to maintain combustion gases within temperature limits.

These combustion gases are expanded through a turbine and are exhausted to atmosphere either direct or through various types of exhaust-heat recovery apparatus.

Commercial Applications in the United States

The first nonmilitary applications of combustion gas turbines in the United States were in 1949. These included a gas-turbine-powered electric locomotive used on the lines of the Union Pacific Railroad and a gas turbine used for power generation in a station of the Oklahoma Gas and Electric Co. Other units are now in service in stations of the Central Maine Power Corp., the Bangor Hydro Electric Co. in Maine, the Central Vermont Public Service Co., and the Public Service Co. of Okla.

In addition to the General Electric gas-turbine units now in service, as listed above, more than 50 G-E com-

W. B. Wilson and W. C. Bloomquist, Industrial Engineering Div., General Electric Co., Schenectady, N. Y.

bustion gas turbines are on order at the present time.

Gas-Turbine Designs Available

Many different cycle arrangements have been considered for the gas turbine. There is the open cycle,

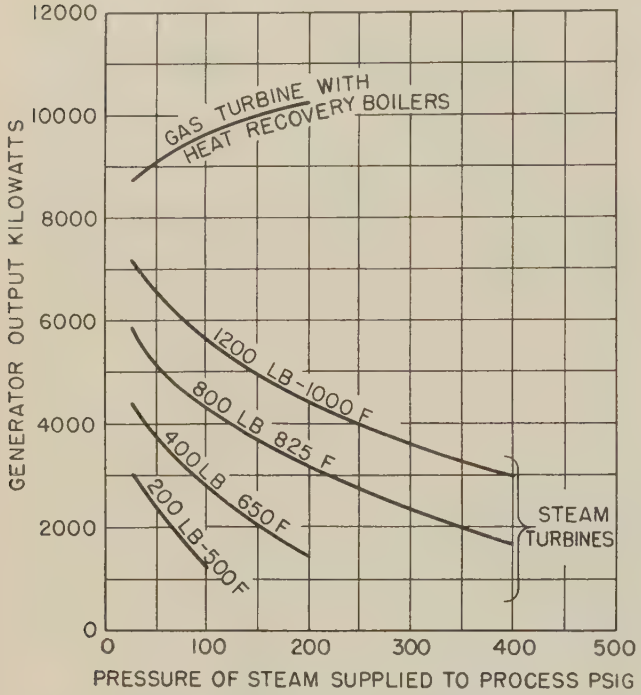

Fig. 1. Electric power which can be generated by simple-cycle gas turbines and steam turbines when supplying 100,000 pounds of steam per hour for process

in which atmospheric air is used once in its passage through the compressor and turbine; the closed cycle where the same atmospheric air is used over and over and is heated from an external source; and combinations of the two in varying degree. The efficiency of any of these cycles will depend upon the extent to which intercooling, regeneration, and other refinements are employed.

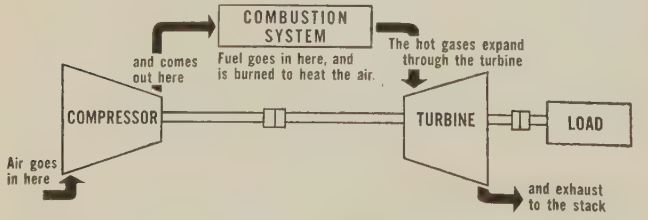
COMBUSTION SYSTEM
and comes out here
Fuel goes in here, and is burned to heat the air.
The hot gases expand through the turbine
COMPRESSOR
TURBINE
LOAD
Air goes in here
and exhaust to the stack

Fig. 2. Schematic diagram of a simple-cycle gas-turbine unit

When all things are considered, the open-cycle arrangement has many very desirable features and this is the cycle selected for the first units developed by the General Electric Co.

Three types of combustion gas-turbine units have been developed by the General Electric Co. for industrial, locomotive, pipe-line pumping, and utility applications. These include:

1. A simple-cycle unit rated 4000 kw. A cross section is shown in Fig. 3.

A gas-turbine power plant of this type, as installed for electric power generation in a plant of the Central Maine Power Corp., is shown in Fig. 4. The same type of unit installed in a plant of the Oklahoma Gas and Electric Co. is shown in Fig. 5. This is a gas-tur-

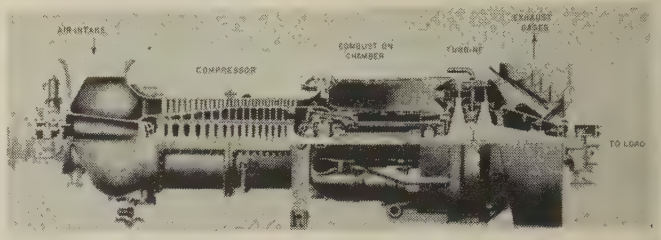

Fig. 3. Cross section of a 4000-kw., simple, open-cycle gas turbine

bine generator unit complete with all required auxiliaries, compactly arranged and requiring a floor area of only 8 feet 9 inches by 47 feet. No basement is necessary, and the required foundation is very simple.

Gas-turbine power-plant cycle efficiency for the Oklahoma installation was approximately 65% because heat recovered from the exhaust gases is utilized to heat feedwater for an existing steam plant. A view of this heat-recovery equipment is shown in Fig. 6,

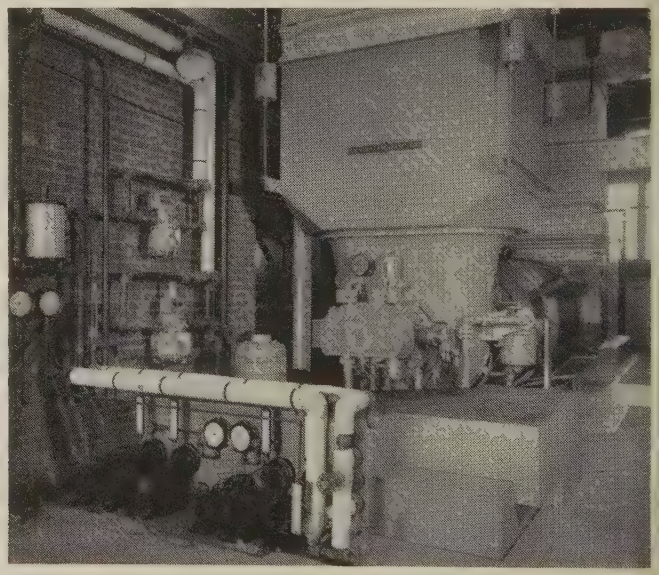

Fig. 4. A 3500-kw. gas-turbine generator set at Farmingdale Power Station of the Central Maine Power Corp.

located just outside the turbine room with the gas-turbine exhaust gases passing through the feedwater heater and exhausting to atmosphere through the stack in the background. Heat recovery from the exhaust gases of a 4000-kw. unit of this type, in reasonably sized feedwater heaters or exhaust-heat recovery boilers, is approximately 40 million B.t.u. per hour. This type

of unit with exhaust-heat recovery should find wide use in the paper industry.

2. Cycle arrangement of a regenerative-cycle unit rated 3500 kw. is shown in Fig. 7 and a cross section of the unit in Fig. 8.

An artist's rendering of a gas pipe-line station with

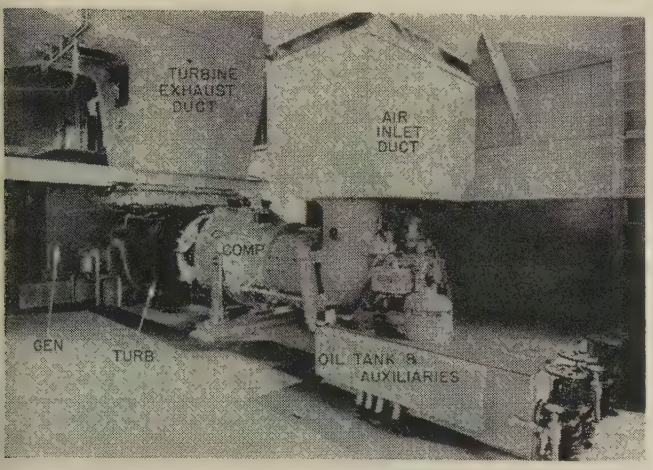

Fig. 5. A 4000-kw. gas-turbine generator set at the Belle Isle Power Station of Oklahoma Gas & Electric Co.

two 5000-hp. gas-turbine driven compressors is shown in Fig. 9. The regenerators are furnished as a part of the turbine equipment and serve as a base for the exhaust stack. In this arrangement air ducts to compressor suction come in overhead. The turbine exhaust duct and the air ducts to and from the regenera-

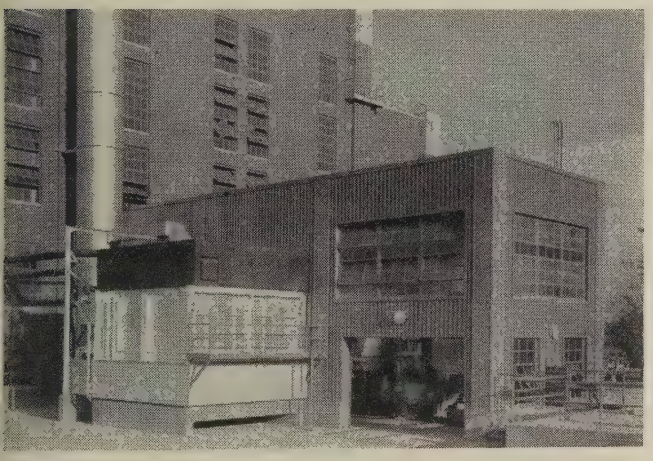

Fig. 6. Building housing 4000-kw. gas-turbine set at the Belle Isle Power Station of the Oklahoma Gas & Electric Co. Exhaust-heat recovery equipment is located outside the building in the left foreground

tors are arranged below the turbine. This type of unit can be used to generate process steam by using an exhaust-heat recovery boiler instead of the regenerator. This type of unit is also suitable for various mechanical drives, including variable speed applications.

3. Cycle arrangement of a compound-cycle unit of unit rated 5000 kw. is shown in Fig. 10 and a cross ection of the unit in Fig. 11.

An artist's rendering of this 5000-kw. power plant is shown in Fig. 12. This shows the gas turbines and compressors, the generator with its direct-connected exciter, the intercoolers, and the regenerators. Figure 13 shows a power plant of this type on test in the factory before installation in a plant of the Central Vermont Public Service Co. in Rutland. This unit requires a floor area of only 27 feet 10 inches by 49 feet 8 inches. A unit of this type, in service in a plant of the Bangor Hydro-Electric Co. in Maine, is shown in Fig. 14. Another unit is installed in a plant of the Public Service Co. of Oklahoma.

This type of unit was designed primarily for power generation only and is expected to find its widest use in the utility industry.

The efficiency of these gas-turbine generator units, operating without additional exhaust-heat recovery apparatus, ranges from approximately 16% for the simple-cycle unit, 22.5% for the regenerative-cycle unit, to 26.5% for the compound cycle unit. These efficiencies are based on the higher heating value (HHV)

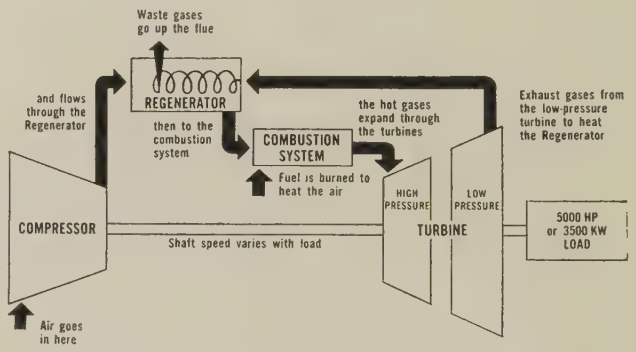
Waste gases go up the flue
REGENERATOR
and flows through the Regenerator
then to the combustion system
COMBUSTION SYSTEM
the hot gases expand through the turbines
Exhaust gases from the low-pressure turbine to heat the Regenerator
Fuel is burned to heat the air
HIGH PRESSURE
LOW PRESSURE
COMPRESSOR
TURBINE
5000 HP or 3500 KW LOAD
Shaft speed varies with load
Air goes in here

Fig. 7. Schematic diagram of a regenerative-cycle gas-turbine unit

of the fuel and differ primarily because of the degree of intercooling and regeneration employed.

When heat can be recovered from the turbine exhaust gases for use in process, then power-plant cycle efficiency may be just as high when using the simple-cycle unit as when the compound-cycle unit is used. It is simply a matter of selecting the type of unit which will give the best over-all plant heat balance for each particular application.

Data on temperatures and flows included in Fig. 15 for the various types of gas-turbine units will be useful in studying exhaust-heat recovery applications.

Approximate fuel consumptions for the units shown in Fig. 15 are as follows:

86 million B.t.u. per hour for the simple-cycle unit.
54 million B.t.u. per hour for the regenerative-cycle unit.
65 million B.t.u. per hour for the compound-cycle unit.

These approximate values are based on the HHV of distillate oil fuels and output at the generator terminals. Actual fuel consumption (HHV) will depend upon the relation between HHV and LHV of the fuel actually used.

One interesting characteristic of the gas turbine is the effect of ambient temperature on its output; the

lower the temperature the greater the output. For example, with an ambient temperature of approximately 40°F., the output of the simple or regenerative-cycle units is increased approximately 25% over the 80°-F. rating.

APPLICATIONS

Now for a brief summary of some of the ways these gas-turbine units can be applied to supply mill requirements for steam and electric power.

Exhaust-Heat Recovery Boilers

Figure 1 shows the relation between the gas-turbine generator kilowatt output and the steam output from the exhaust-heat recovery boilers and inmediately suggests an application for steam generation.

The arrangement for one mill requiring both process steam and electric power is shown in Fig. 16. Heat in the gas-turbine exhaust gases was to be recovered for the generation of steam in two boilers at two different pressures—175 and 40 p.s.i.g. From the last boiler the exhaust gases pass through an economizer to heat feedwater for the boilers before exhausting to the stack.

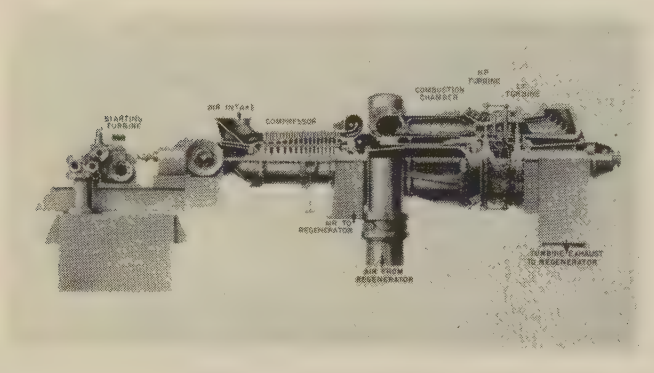

Fig. 8. Cross section of a 3500-kw. regenerative-cycle gas-turbine unit

This arrangment would provide a total of 39,000 pounds of steam per hour and 3500 kilowatts of electric energy. This is a ratio of approximately 11 pounds of process steam for each kilowatt-hour. Over-all gas-turbine plant cycle efficiency for this steam and power generation is approximately 70%.

These requirements could also be supplied by a double automatic-extraction-condensing steam turbine plant. Over-all plant thermal efficiency of the steam turbine cycle would be approximately 52%. This is lower than the gas-turbine plant efficiency for this particular application because the ratio of process steam to electric power is low and a high percentage of the electric energy must be produced by the condensing section of the steam turbine which operates at a plant thermal efficiency of only 20 to 25%. (If the process steam requirements were appreciably greater, then the efficiencies of the two cycles would be comparable.)

Use of the gas turbine with its higher cycle efficiency for this application would result in a fuel saving of over $60,000 per year based on a plant factor of 80% and a fuel cost of 30 cents per million B.t.u. Initial cost of the gas-turbine plant should be lower and the cooling water requirements would be about one tenth that required by a condensing steam-turbine plant of the same kilowatt rating.

Supplementary Fuel Firing

When required steam flow from the exhaust-heat recovery boilers can be increased by supplementary fuel firing.

Therefore, the gas turbine can be applied where the ratio of kilowatts to process steam (Fig. 1) is higher than the upper limit of the noncondensing steam plant

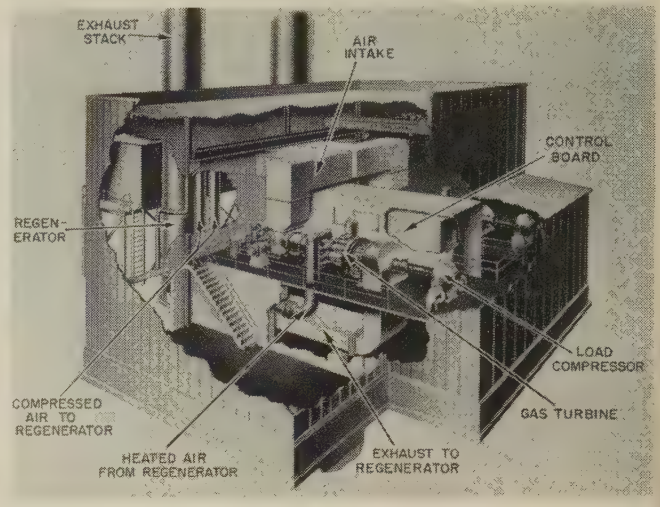

Fig. 9. Artist's rendering of a two-unit gas-turbine-powered natural gas pipe-line compressor station

but lower than the gas turbine operating with exhaust-heat recovery boilers alone. (Steam turbine 20 to 40 and gas turbine 10 to 12 pounds process steam per kw.-hr.) This is the area where by-product power generation would have to be supplemented by condensing power in a straight steam-turbine plant.

In this case of supplementary firing, heat recovered from the gas-turbine exhaust gases is supplemented by heat from additional fuel burned in the turbine exhaust

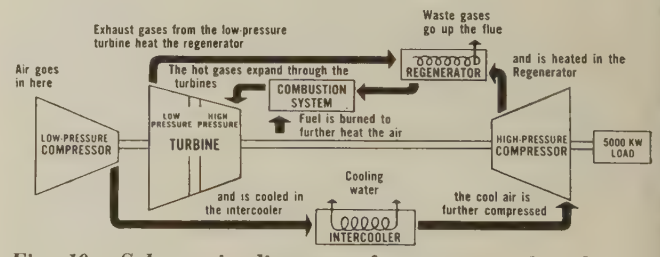

Fig. 10. Schematic diagram of a compound-cycle gas-turbine unit

gases between the turbine and the exhaust-heat recovery boiler. The additional cost of providing for this supplementary firing is low. All that is necessary is the addition of a section of refractory-lined ductwork and installation of the necessary fuel nozzles just ahead of the exhaust-heat recovery boilers. A schematic diagram for such an arrangement is shown in Fig. 17. This shows the exhaust-heat recovery boiler with the fuel nozzles for supplementary firing located just ahead

of the boiler. Because of the large amount of excess air (approximately 450 per cent) used in the gas-turbine cycle, no additional air is required for combustion of this supplementary fuel. This further simplifies the installation and operation because forced-draft fans and their attendant controls are not required.

Depending on the balance between electric power and steam requirements supplementary firing might be

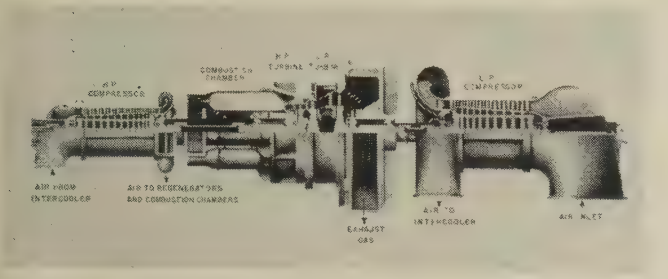

Fig. 11. Cross section of gas turbine for 5000-kw. turbine-generator set

used continuously to increase the output of the exhaust-heat recovery boilers to relieve the demand on conventional fuel-fired boilers. In other mills supplementary firing might be used to supply occasional peaks in steam load.

In still other mills supplementary firing might be used during an outage of conventional fuel-fired boilers. The output of the exhaust-heat recovery boilers can

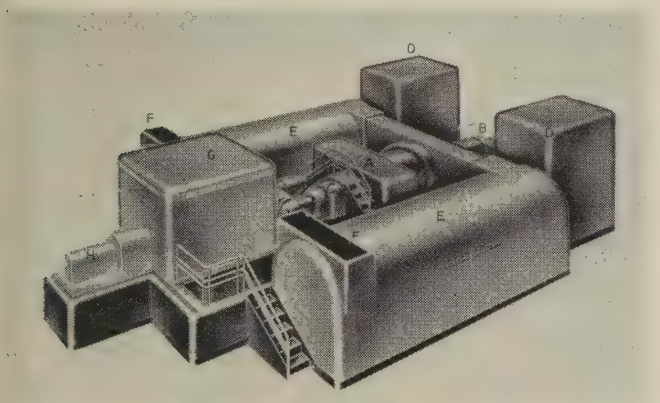

Fig. 12. An artist's rendering of a 5000-kw. compound-cycle gas-turbine generator set

A—Gas turbine. B—Low-pressure compressor. C—High-pressure compressor. D—Intercoolers. E—Regenerators. F—Exhaust ducts. G—Generator. H—Exciter.

easily be doubled or tripled—say from 40,000 to 80,000 or 120,000 pounds per hour steam flow—by supplementary firing. This being the case, the capacity of fuel-fired boilers normally maintained as stand-by can be materially reduced with the attendant reduction in first cost and fixed charges.

In special cases, existing fuel-fired boilers might be considered for exhaust-heat recovery boilers with supplementary firing—for instance, an old boiler which can no longer be operated at full design pressure or a boiler which is no longer economical to operate as a regular fuel-fired boiler because of maintenance or efficiency. If the design of such a boiler is suitable, it might be economical to use it in conjunction with the gas turbine for exhaust-heat recovery using supplementary firing if required.

Turbine Exhaust Gases Can Be Used as Combustion Air for Fuel-Fired Boilers

High gas-turbine cycle efficiencies can also be realized in mills where the combustion gas-turbine exhaust gases can be used as combustion air for fuel-fired boilers. Because of the large amount of excess air used in the gas-turbine cycle to limit temperatures, the turbine exhaust contains approximately 17% oxygen compared to 21% for free air. Because so much oxygen is left in the exhaust gases, they can be used as preheated combustion air for fuel-fired boilers which are not equipped

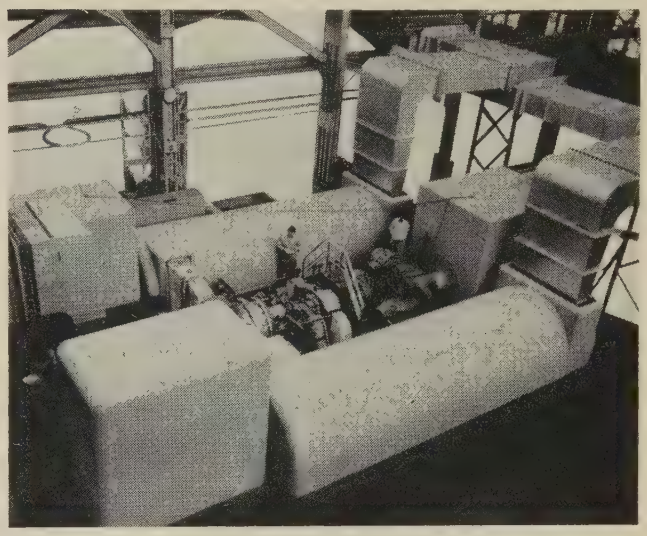

Fig. 13. Picture showing test setup of 5000-kw. compound cycle gas-turbine generator set for Central Vermont Public Service Co.

with air heaters. One 4000-kw. gas turbine can supply combustion air required by a fuel-fired boiler having an output of approximately 250,000 pounds of steam per hour. This cycle arrangement is shown in Fig. 18.

When the gas-turbine exhaust gases can be utilized as combustion air for fuel-fired boilers equipped with economizers, the gas-turbine plant cycle efficiency can be as high as 80% when credited with heat in the exhaust gases. For the same per cent excess air in the fuel-fired boilers, boiler stack losses will be slightly higher when gas-turbine exhaust gases are used for combustion air.

Turbine Exhaust Gases Can Be Used for Drying Boards

Still another application is the use of the gas-turbine exhaust gases for drying fiberboard, gypsum board, or even for the kiln drying of lumber.

Because of the high efficiency of fuel combustion in the gas turbine, turbine exhaust gases can be used for

the direct drying of many products without danger of contamination.

Although exhaust-gas temperature, as it leaves the turbine, may be too high for most of these applications, the proper drying temperature can be automatically maintained by mixing atmospheric air with the turbine exhaust gases for temperature control as required. Humidity of the drying air can also be easily controlled by spraying water into the hot exhaust gases when required.

Depending upon physical arrangement of equipment within the plant, the gases leaving the exhaust-heat recovery boilers could also be used for drying.

SELECTION OF PROPER TURBINE—STEAM OR GAS

When the gas turbine is credited with the heat in its exhaust gases which can be recovered for various uses throughout the mill, its cycle efficiency can be as high as 70% or more. This is comparable to the cycle efficiency of a good noncondensing steam-turbine plant exhausting steam for process use—the kind of plant with which paper mill engineers are so familiar.

Fig. 14. A 5000-kw. gas-turbine generator set at station of Bangor Hydro-Electric Co.

How then can we select the proper cycle?

Referring again to Fig. 1 this curve shows that steam turbines should be considered when the ratio of electric power to process steam is low—say 2500 to 5000 kw. per 100,000 pounds per hour steam flow which is 20 to 40 pounds of process steam per kw.-hr. Gas turbines should be considered when the ratio of electric power to process steam is high—say 8000 to 10,000 kw. per 100,000 pounds per hour steam flow which is 10 to 12 pounds process steam per kw.-hr.

In the intermediate range of process steam requirements, the condensing-extraction turbine, the gas turbine utilizing exhaust-heat recovery boilers with supplementary firing, or a combination of the two may be selected.

This ratio of process steam per kilowatt-hour varies widely in different mills. The over-all average is perhaps no more than 25 pounds per kw.-hr. and, with the rapid increase in the use of electric power, the ratio is likely to decrease still more in the future. In some new mills and particularly in the expansion of existing mills, the ratio of process steam to electric power requirements

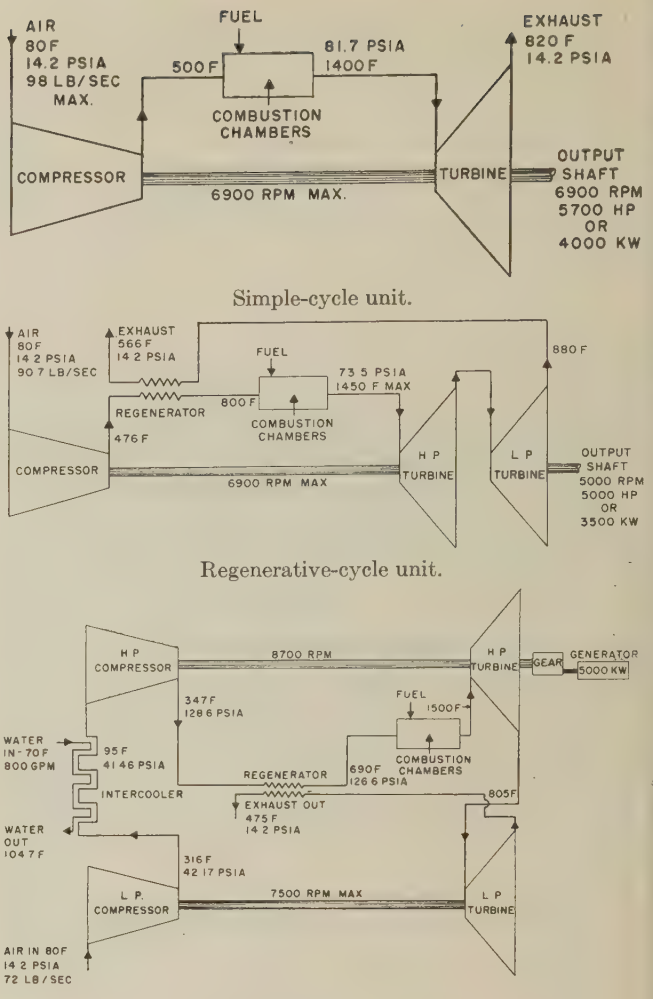

Fig. 15. Schematic diagram of different types of gas-turbine units with pressures, temperatures, and flows indicated

may be quite low. A low ratio favors the gas turbine.

FUEL

Much effort is being expended at the present time to develop means of using a wide variety of fuels for the combustion gas turbine. Based on experience to date,

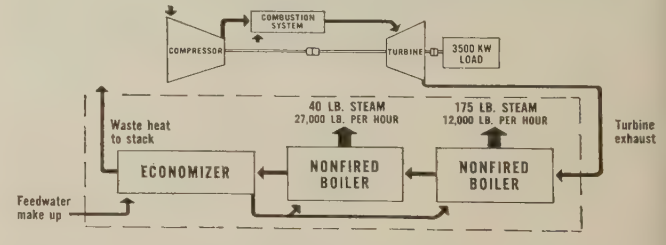

Fig. 16. Schematic diagram of simple-cycle gas turbine with exhaust-heat recovery boilers and economizer to recover heat from turbine exhaust gases

gas or distillate oils are excellent fuels. No doubt, in the future, satisfactory equipment will be developed so other fuels can be used commercially. At the present time, the steam-turbine plant can utilize a much wider variety of fuels.

This is a handicap for the gas turbine in areas where the cost of suitable fuel is higher than that of fuels for other power plants.

This handicap is partially overcome by the greater simplicity and lower installed cost for the gas turbine.

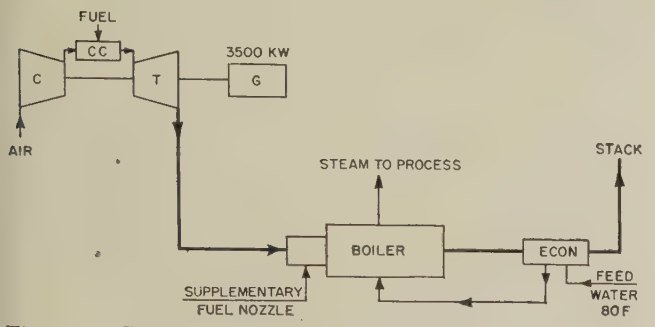

Fig. 17. Gas-turbine and exhaust-heat recovery boiler with supplementary fuel firing

In areas where the same fuel would not be used in the different types of power plants, the relative fuel costs must be considered simultaneously with the plant thermal efficiency. In plants where the same fuel

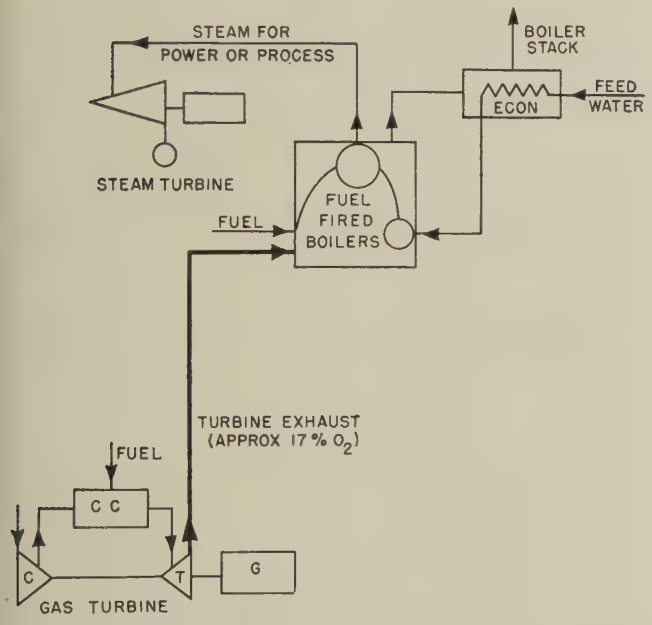

Fig. 18. Schematic diagram showing a gas turbine supplying combustion air for fuel-fired steam boilers

would be used, relative plant thermal efficiency is a direct measure of relative fuel costs.

SUMMARY

Let's make a few comparisons between the gas-turbine and the steam-turbine plant.

Initial Cost

From available data, it is estimated that cost of a new gas-turbine plant is approximately three-fourths that of a comparable steam plant.

However, each case should be carefully studied by competent engineers so accurate and complete installation and operating costs are established. With such information the proper selection of the source of power can be made whether this be purchased power or local generation or a combination.

Control

The gas-turbine plant has one simple control panel shown in Fig. 19. The simplicity of this plant makes complete automatic control practical.

Efficiency

When properly applied—both steam and gas turbines operate with high cycle efficiencies (the gas turbine when ratio of electric energy to heat energy is high—the steam turbine when this ratio is low.)

Reliability and Maintenance

A total of more than 30,000 hours of operation have been accumuated on the gas turbines now in service and the service record has been very good. Even

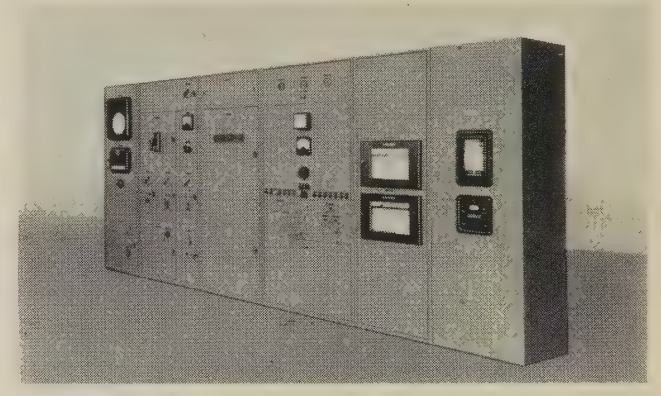

Fig. 19. Typical control panel for a gas-turbine unit

though this is equivalent to more than three years of operation, it is realized that an accurate prediction of reliability and maintenance cannot be based on this relatively short period of operation. However, the designers are confident that the gas-turbine plant will compare favorably with the steam-turbine plant. It might be well to point out here that the combustion gas turbines for commercial land applications are designed with safety factors comparable to those used in steam turbine design so far as long life and low maintenance are concerned.

This comparison could go on but there is one important thought that should be remembered. Gas turbines have been designed, manufactured, tested, and operated in commercial service and there are many applications where use of these gas turbines will reduce the cost of heat and power.

In mills where the ratio of electric energy to heat energy is high, consider the gas turbine—its use may be very profitable.

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The Properties of Saran-Coated Papers Prepared by a Hot-Melt Process

L. F. SWEC and H. L. CLACK

Sarans, copolymers of vinylidene chloride, have been applied to paper in several different ways to utilize their unique properties in the packaging field. They have been applied from solvent and aqueous emulsion systems. Films of saran have been used unsupported and laminated to paper. The hot-melt method of applying resin to paper, which has been successfully used in the past with polyethylene and copolymers of vinyl chloride, has more recently been used to apply saran to paper. A comparison of the properties of these polymers shows that saran excels in water, water vapor, gas, oil, and chemical resistance. Certain features of the coating process are briefly described. Variations of properties of paper coated with saran by the hot-melt process as other parameters are changed are discussed. The following comparisons are shown: (1) water vapor transmission rate versus coating weight; (2) WVTR versus aging at various temperatures; (3) WVTR versus plasticizer loss; (4) oxygen, nitrogen, and carbon dioxide transmission rates; (5) resistance to various liquid chemicals; and (6) changes in burst, tear, and tensile strength of raw stock after various coating weights of saran have been applied. Uses are suggested based on the properties of the saran-coated paper.

Since the development of the synthetic plastics industry, many attempts have been made to combine the functional properties of plastics with the reinforcing properties of paper to give special packaging materials. Cellulosics, styrene copolymers, vinyl chloride copolymers, polyethylene, and saran (vinylidene chloride copolymers) are prominent among those that have been used with varying degrees of success.

There are a number of general, well-known methods of applying these plastics to paper. These include solvent solutions and emulsions, latexes, plastisols, free-film laminations, and hot melts. The hot-melt technique offers the greatest possibilities for economy because such problems as drying, fusion of particles, solvent recovery, fire hazards, and poor adhesive bonds are eliminated. Only the resin and paper must be kept in inventory. The equipment, though not inexpensive, occupies a minimum of space and usually permits higher operating speeds. In addition, there frequently are quality advantages in the finished product when such extraneous materials as adhesives, emulsifying agents, and residual solvents are not present.

In the field of hot-melt coatings two types of thermoplastics, vinyl chloride copolymers and polyethylene, have been quite successful. Recently saran has been introduced into this field because it has a combination of outstanding properties not obtained with other materials. This has been possible through improvements in saran compounding, the development of high capacity extruders, and refinements in hot-melt coating techniques. A comparison of the properties of saran with polyethylene and a vinyl chloride-vinyl acetate copolymer is given in Table I. It must be remembered that the saran and the vinyl copolymer are compounded materials and that the additives can materially affect these properties.

The most outstanding properties of saran-coated paper as a packaging material are its resistance to water vapor, liquid water, gases, oils, greases, and most chemicals. These properties will be discussed in greater detail later.

The hot-melt process for coating saran on paper requires a specially constructed saran extruder for feeding the molten saran to the applicating unit. Special nickel-alloy metals are required for the screw, torpedo, and liner. This is necessary because most commonly

Table I. Comparison of Properties of Plastics for Paper Coating

Type	*Saran (1) vinylidene chloride-vinylchloride copolymer*	*VB 1925 natural (2) vinylchloride vinylacetate copolymer*	*Polyethylene (3) 19,000 mol. wt.*
Specific gravity	1.68	1.27	0.92
Lb./mil/ream (3000 sq. ft.)	26.2	19.8	14.4
Sq. ft./lb./mil	115	152	209
High-temperature resistance (nonblocking)	225°F.	200°F.	160°F.
Low-temperature resistance	0°F.	0°F.	−75°F.
Heat sealing range with bar sealer (1/2 sec. dwell time—28 p.s.i. pressure)	320–340°F.	240–260°F.	240–260°F.
Thermal conductivity, 10^{-4} cal./sec./sq. cm./°C./cm.	2.2	3.8	8.0
Dielectric constant, 1000 cycles/sec.	4.2	4.2	2.3
Dielectric strength, volts/mil—2-mil film	3000	2900	4000
Water resistance (Jan-P-117 procedure) (approx. 2 1/3 mils coating on paper)	475–525 hr.	8–12 hr.	24–48 hr.
WVTR (g./100 sq. in./24 hr. at 100°F.—95% R. H. for 2 mils coating on paper—coated side exposed to moisture)	0.13	4.1	0.60
Dry gas transmission, cc./100 sq. in./24 hr. at 77°F. for 2 mils thickness of plastic—plastic side exposed to gas			
Nitrogen	0.05	18[a]	9
Oxygen	0.10	80[a]	50
Carbon dioxide	0.45	530[a]	166

[a] Results for 2-mil unsupported film. The gas transmission data for saran and polyethylene were obtained on coated paper.

L. F. Swec, Chemical Engineer, H. P. Smith Paper Co., Chicago, Ill., and H. L. Clack, Coatings Technical Service, The Dow Chemical Co., Midland, Mich.

used metals catalyze the evolution of hydrogen chloride during the extrusion process. The volume of saran present in the heated zones is kept to a minimum through the use of a shallow flighted screw and a short barrel. The poor thermal conductivity of the saran necessitates heating it in thin layers to avoid thermal decomposition at the heated metal surfaces and to avoid unmelted saran in the center of the resin layer. Steam heat is used throughout to prevent the development of high localized temperatures. No screens are used that might cause holdup of the saran. The barrel is heated in sections and the screw and torpedo are separately heated. In other words, everything is designed to get the saran up to temperature just as it leaves the extruder and not before.

The paper is preheated to drive off surface moisture before application of the saran in order to obtain a better bond. Surface absorbency of the raw stock promotes better bond by mechanical anchorage although this requires a slightly greater amount of coating for a continuous film. Pinhole-free coatings have been obtained from $1^1/_3$ to 8 mils by metering the plastic to the desired thickness on the paper.

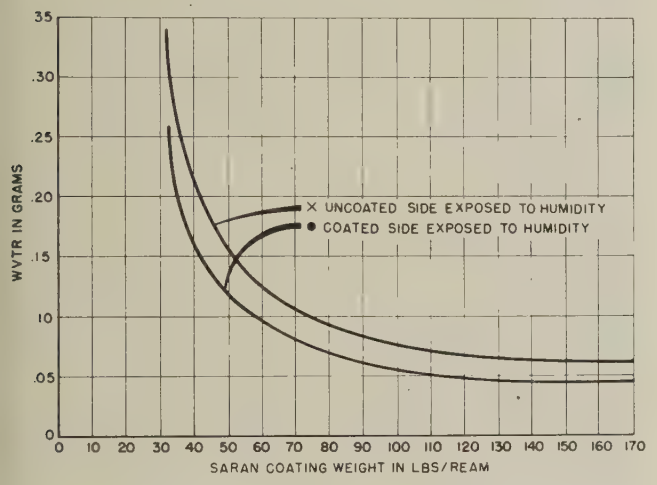

Fig. 1. Water vapor transmission rate of saran coated paper versus coating weight

Immediately after application the coating is tacky, even at room temperature, until a certain degree of crystallization occurs. To prevent blocking, this must be accomplished before winding into a finished roll. Since the coating is unoriented, crystallization must occur spontaneously and can be aided by the incorporation of pigments such as carbon black and titanium dioxide in the saran. A controlled temperature of the web at approximately 170°F. is also ideal for rapid crystallization. Above and below this temperature slower crystallization occurs.

WATER VAPOR TRANSMISSION RATES

Saran-coated paper is an outstanding barrier to water and water vapor. In Fig. 1 the effect on the water vapor transmission rate (WVTR) of varying the coating weight of white pigmented saran (from 33 pounds to 167 pounds per ream) on 30-pound bleached kraft is shown. The water vapor transmission rates were measured in a General Foods cabinet at 100°F. and 90 to 95% R. H. These results were all obtained on samples creased (accordion fashion) according to the procedure described in the military packaging specification JAN-P-117. It was found that the results on flat samples were essentially the same. The most practical coating weight for most uses is $1^1/_2$ to 2 mils or 40 to 52 pounds per ream. It has been shown that

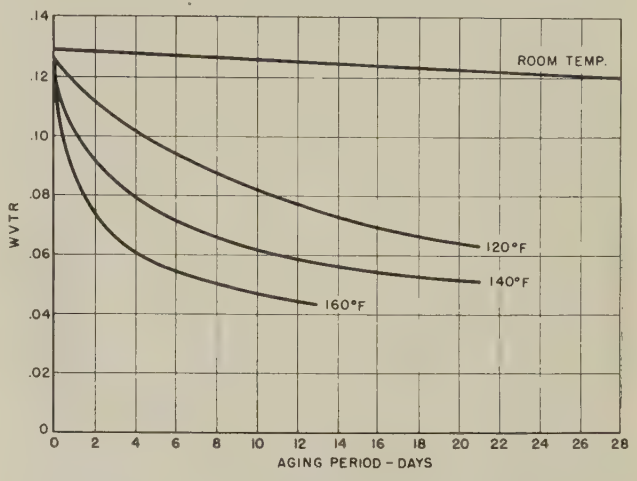

Fig. 2. Water vapor transmission rate versus aging for a 38-pound per ream black saran coating

WVTR's are higher when the paper side is exposed to the moisture than when the film side is exposed. The penetration of individual fibers into the coated film provides a mechanical anchorage for the coating, but possibly also provides wicks for vapors and liquids. The reason for the rapid rise in the WVTR in the coating weight range of 30 to 40 pounds per ream is that a discontinuous film was being approached. Above 105 pounds per ream (4 mils coating), increasing the coating weight does very little to improve the WVTR.

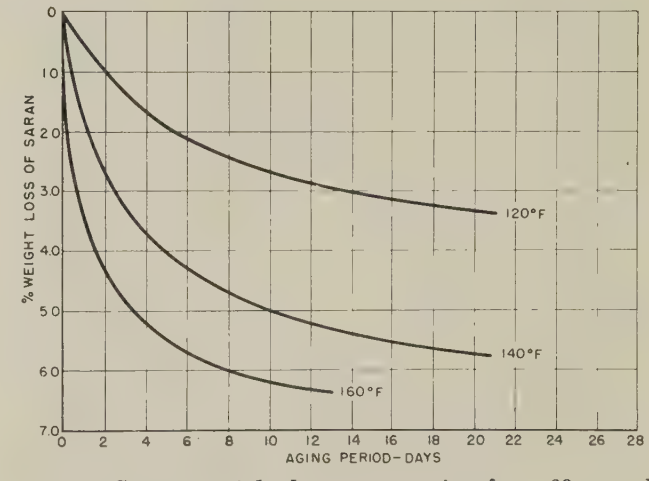

Fig. 3. Coating weight loss versus aging for a 38-pound per ream black saran coating

The above WVTR results were all obtained on unaged samples. A study was made on the effect on the water vapor transmission rate of aging the coated paper at various temperatures. In Fig. 2 it can be seen that

room temperature aging had a negligible effect on the WVTR. As increased temperatures were used, a more rapid decrease in the WVTR was obtained with an apparent tendency to eventually level off. These tests were run on flat samples which were aged by hanging

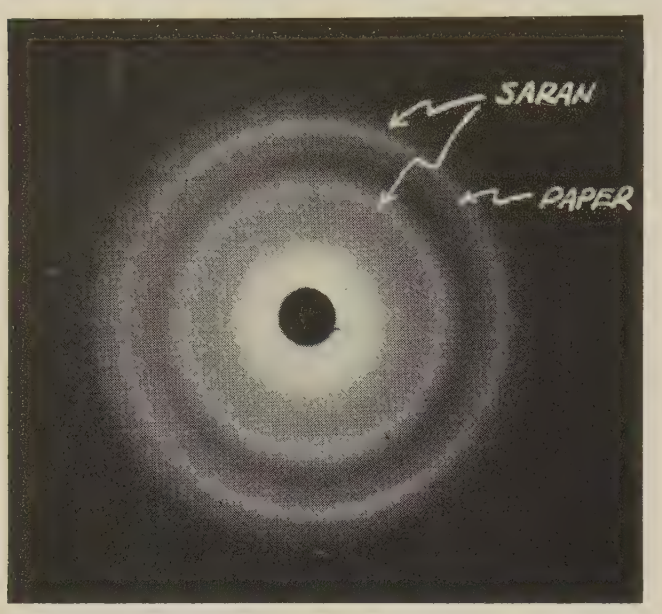

Fig. 4. X-ray diffraction pattern of crystallized saran on kraft-aged room temperature

the individual samples in ovens at 120°, 140°, and 160°F. In all cases the samples consisted of 38 ± 1 pound of black pigmented saran coated on 60-pound wet strength kraft.

The effect of creasing the samples on the above

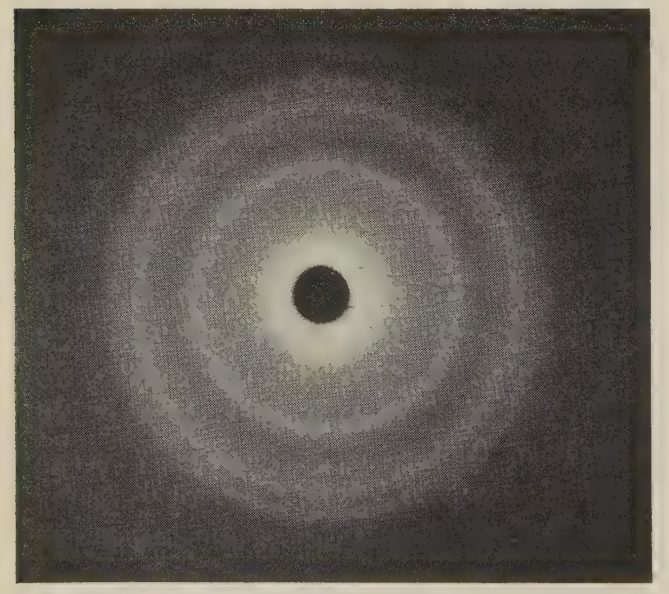

Fig. 5. X-ray diffraction pattern of crystallized saran on kraft—aged 160°F.

WVTR results was again studied. It was found that creasing the individual samples before aging had no appreciable effect. However, creasing after aging, particularly those samples aged at the higher temperatures, resulted in slightly higher WVTR's in almost all cases. This indicated a loss in flexibility of the coating.

At first it was not known whether this improvement in WVTR of the coated paper when aged at raised temperatures was due to (1) plasticizer loss, (2) increase in crystallization, or (3) a combination of both. A study was made to resolve these two variables.

In order to check the first variable, the coating weight loss with time of each of the heat-aged samples described above was determined. These results are plotted in Fig. 3 as per cent weight loss versus aging at 120, 140, and 160°F. A marked similarity between the curves in Figs. 2 and 3 can be seen. The weight loss from the coating was confirmed by chemical analysis to be plasticizer loss.

A roll of the same saran-coated kraft was aged for $3^1/_2$ months at 140°F., and samples were periodically taken from the interior of the roll for a flat WVTR reading. A constant WVTR, identical with the room temperature aging curve in Fig. 2, was obtained. Chemical

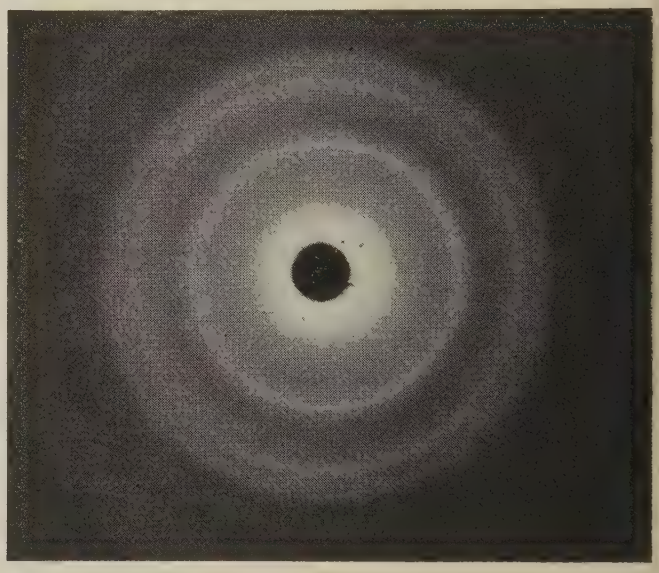

Fig. 6. X-ray diffraction pattern of crystallized saran on kraft—aged in roll at 140°F.

analysis of the coating after the $3^1/_2$-month period indicated only a slight loss in plasticizer content. This indicates that there is a direct correlation between plasticizer loss and water vapor transmission rate.

The degree of crystallization of the saran can be noted qualitatively by studying x-ray patterns of coated paper. Figure 4 is a pattern of crystallized saran-coated paper aged at room temperature for several months. The rings are marked to indicate the important ones due to saran and paper. The more intense the rings, the greater the degree of crystallization.

A study was made of x-ray diffraction patterns of the papers aged 2 weeks at 120, 140, and 160°F. It was found that the higher the temperature of aging for that period, the greater the degree of crystallization. Figure 5 is the x-ray pattern of the saran-coated paper aged at 160°F. When this pattern is compared with Fig. 4 it can be seen that more crystallization has occurred at the higher temperature. This can be done

by comparing the intensity of the diffraction rings due to saran in the two samples aged at different temperatures. The more intense the ring, the greater the degree of crystallization. Sometimes the two samples are exposed to different intensities of x-ray radiation. In this case, it is often difficult to obtain a comparison of degrees of crystallization unless some standard exists that is unchanged by the heat treatment given. Fortunately in these patterns there exists a diffraction ring due to paper that is unchanged by the heat treatment. This ring is indicated in Fig. 4. Using this ring as a comparison it is easier to obtain a more accurate comparison.

This work does not indicate, though, whether the drop in WVTR upon heat aging was due to plasticizer loss or to crystallization. A study of the x-ray diffraction patterns of the coated paper aged at 140°F. (1) in the roll for $3^1/_2$ months and (2) in the sheet form for 2 weeks helps to answer this question. Figure 6 shows the pattern for the sample aged in the roll; Fig. 7 shows the pattern for the sample aged in sheet form. A study of these two patterns, using the paper ring as a standard, shows that, if there is any difference at

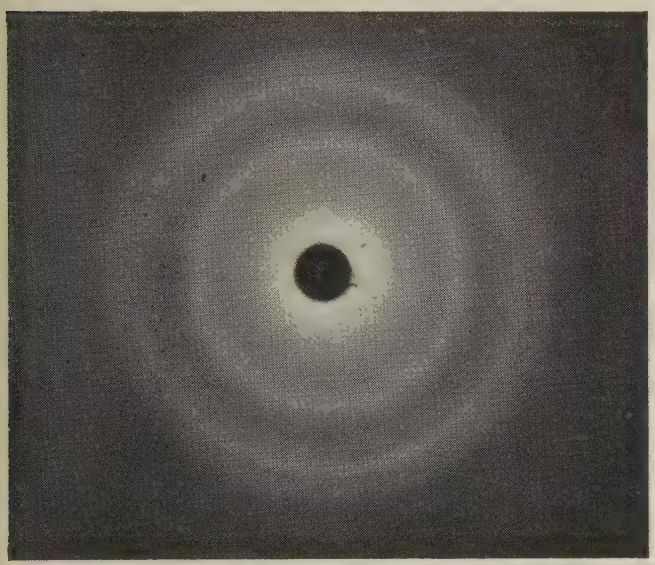

Fig. 7. X-ray diffraction pattern of crystallized saran on kraft—aged in sheet form at 140°F.

all, the sample aged in the roll has crystallized more than the sheet-aged sample. Inasmuch as the sheet-aged sample lost more plasticizer than the roll-aged sample, it can be concluded that the loss of plasticizer on heat aging saran has more effect on the lowering of the WVTR than the increase in crystallization that occurs. This statement is based on the conditions under which these samples were heat aged and might not apply generally.

GAS TRANSMISSION

One of the outstanding properties of saran-coated paper is its resistance to the permeation of gases. Table I compares the permeability of 2-mil coatings of saran and polyethylene on kraft with a 2-mil film of vinyl copolymer using dry oxygen, carbon dioxide, and nitrogen as the gases.

Listed in Table II are the conditions for the gas transmission tests on the various plastics.

The gas transmission rates for wet gases (85 to 90% R. H.) have usually been found to be higher than for dry gases, although no definite factor has been established.

Table II. Conditions Used in Obtaining Gas Transmission Data

	Saran	*Vinyl copolymer*	*Polyethylene*
Temperature, °F.	73	77	90
Pressure differential, mm. Hg	760	Not reported	550

Gas transmission studies have been made on several samples of saran containing the same base polymer but different formulating ingredients. Comparisons were made between formulations containing different plasticizers, carbon black, titanium dioxide, and no pigment. It was found that these ingredients did not change gas transmission in even the most extreme case by more than a factor of three.

CHEMICAL RESISTANCE

The chemical resistance of saran hot-melt coated paper to a wide variety of liquid chemical types is superior to that of any plastic-coated paper in the same or lower price range. A carbon black pigmented saran hot-melt coating (40-pound coating) on 60-pound natural kraft was used to prepare a number of 6 by 8-inch I.D. heat-sealed pouches with seals on three sides. Fifteen liquids of different chemical types were selected. One hundred milliliters of liquid was placed in each pouch and the fourth seal made. Weight loss was periodically measured and observations made on the appearance of the outside of the pouches. The tests were run at 73°F. and 50% R. H. The per cent weight loss of each liquid for a 1-week period is recorded in Table III. In all but a few cases noted

Table III. Liquid Chemical Resistance of Saran Hot-Melt Coated Paper

Reagent	*Weight loss/week, %*	*Comments*
Water	0.10	
Prune juice	0.16	
5% HCl	0.71	
10% Lactic acid	0.11	Small pinhole failures
10% Acetic acid	0.12	
5% Caustic soda	...	Pinholes and seal failures
28% Ammonium hydroxide	3.58	
2B Alcohol	0.31	
Acetone	67.5	
Ethyl acetate	39.8	General transudation, stains paper
Toluene	32.3	
Turpentine	0.00	
Mineral spirits	0.37	
Mineral oil (SAE-30)	0.06	Small pinhole failures
Ethylene glycol	−0.12	Probable moisture gain

under "Comments" the loss represented vaporization through the barrier material without visibly affecting the saran coating. In the few cases where the liquid did not evaporate as fast as it penetrated the coated paper, a general staining of the paper on the outside of the pouch was observed.

It can be concluded that saran hot-melt coated paper is an excellent barrier for all the liquids listed with the exception of strong alkalis, acetone, ethyl acetate, and toluene. The alkalies attacked the coating. A high vapor transmission was obtained with acetone, ethyl acetate, and toluene which did not otherwise affect

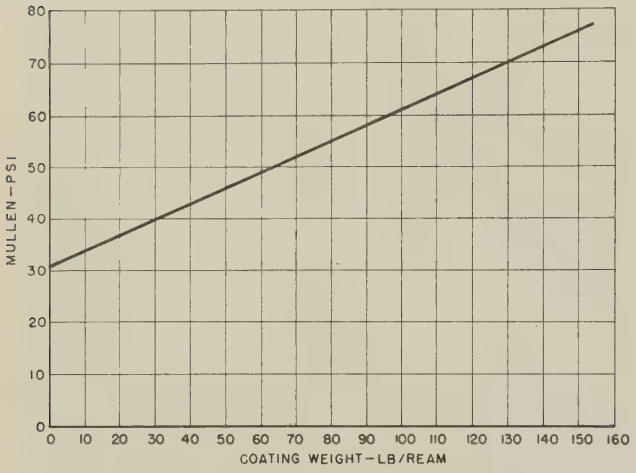

Fig. 8. Mullen bursting strength versus coating weight of white saran on 30-pound bleached kraft

the coating. The results with water, prune juice, acetic acid, alcohol, turpentine, mineral spirits, mineral oil, and ethylene glycol were exceptionally good. There are a few solvents which will dissolve or swell saran to a small extent, such as tetrahydrofuran, cyclohexanone, 1,4-dioxane, and orthodichlorobenzene. They are much better solvents at elevated temperatures.

PHYSICAL STRENGTH PROPERTIES

The bursting, tearing, and tensile strengths of raw kraft paper are all improved considerably after hot-

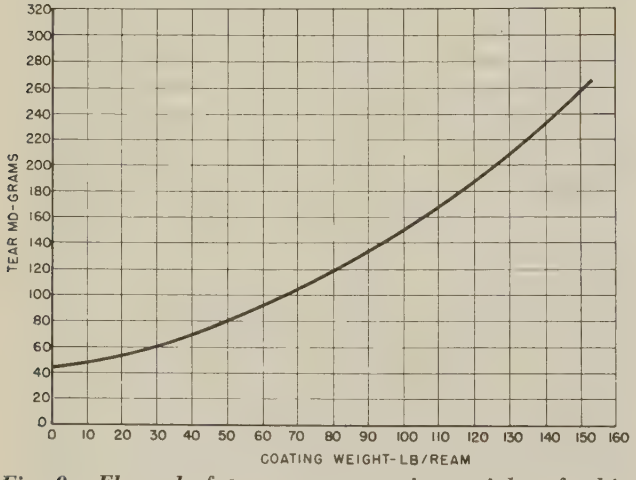

Fig. 9. Elmendorf tear versus coating weight of white saran on 30-pound bleached kraft

melt coating with saran in proportion to the amount of coating. In Fig. 8, the Mullen bursting strength with 2 mils of coating is approximately 50% greater than that of the raw stock. In Fig. 9, the Elmendorf tearing strength with 2 mils of coating is approximately 85% greater than that of the raw stock. In Fig. 10, tensile strength with 2 mils of coating is approximately 80% greater than that of the raw stock. The increases in the strength values with increased coating weight shown in Figs. 8, 9, and 10 are considered to be significant for saran hot-melt coated papers. The same thickness of polyethylene on the same paper has given lower strength values than those reported here for saran. The data in Figs. 8, 9, and 10 were obtained using a titanium dioxide pigmented saran hot-melt coating. It has been found that small amounts of both titanium dioxide and carbon black milled into the saran resin slightly improve the physical strength values of the coated paper over those obtained with clear saran.

CONCLUSIONS

The outstanding properties of saran-coated paper that should be of interest in the packaging field are:

1. Low water vapor transmission rate.
2. Low gas transmission rate.
3. Excellent water resistance.
4. Excellent chemical resistance.
5. Increased strength of paper.

These properties should enable it to do packaging jobs never before accomplished with coated papers or laminates.

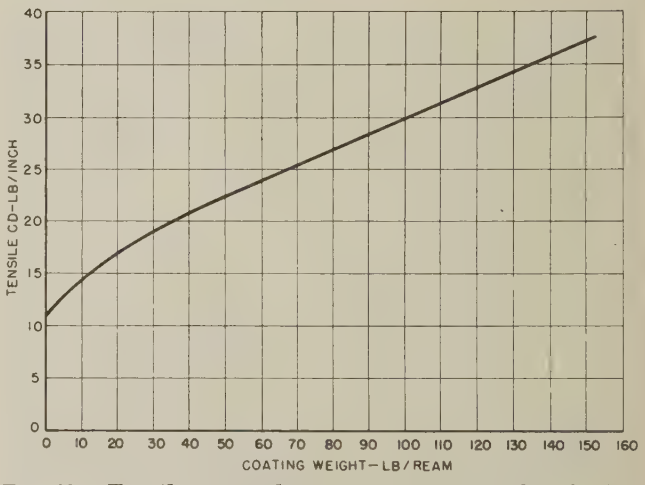

Fig. 10. Tensile strength versus coating weight of white saran on 30-pound bleached kraft

On the basis of the above properties, efforts are being made to put saran-coated papers in the following fields (*4*):

1. Barrier papers—where water vapor and grease resistance are required.
2. Cap liners—where water vapor, gas, and chemical resistance are required.
3. Multiwall bags—where water, chemical, and gas resistance are required in addition to bag strength.
4. Liners for paper drums and tubes—where gas, water vapor, and chemical resistance are required.

The unusual combination of properties of saran on paper offers the possibility of many new approaches to old packaging problems.

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The Air Drying of Paper

JAMES J. HIGGINS

Although air drying of paper represents only a small part of the drying carried out by the industry, it is believed to be the most fundamental and, therefore, has been studied as a basis for the determination of the mechanism of drying on hot surfaces. The results show that the paper sheet does not dry at a uniform rate from the leading to the trailing edge. Freeness (from 470 to 800-ml. Schopper-Riegler), formation, and the number of plies have no effect on the rate of drying during the constant rate period. The moisture distribution within the sheet was also studied; this varied slightly with the initial moisture content and appears to be independent of the freeness of the sheet and the rate of drying between 100 and 25% moisture. A mechanism for the flow of moisture during drying is proposed.

A STUDY of the drying of any material is usually undertaken to aid in the design and operation of equipment, and to improve the properties of the product. The drying of paper is an operation of considerable importance in the manufacture of paper since, even though only about 1% of the water used in sheet formation is removed by drying, this represents a major cost in paper machine operation.

Drying in the paper industry consists of two general types: cylinder drying and air drying. Although air drying represents only a small part of all the drying carried on in the industry, it has been studied since it is believed to provide a logical starting point for a fundamental study of the mechanism of water removal from paper sheets. It is hoped that further studies may be extended into the realm of drying on hot surfaces.

Air drying consists in vaporizing the moisture either within or at the surface of the solid and the subsequent removal of the vapor into the surrounding air. Lewis and co-workers (*1, 2*) and Sherwood (*3–6*) have postulated several possible theories for air drying. In general, these theories consider that the drying can be divided into two intervals: the first, in which the drying rate is constant and, the second, in which the rate is continually decreasing.

Realizing the importance of the movement of moisture within the sheet in determining the rate of drying, several investigators have proposed mechanisms for this movement which are dependent upon the structure of the solid. Ceagliski and Hougen (*7*) were able to obtain very good agreement between experimentally obtained moisture distribution curves for the drying of sands and distribution curves theoretically determined assuming that the flow was primarily by capillarity. Hougen, McCauley, and Marshall (*8*) studied and pointed out the limitations of the application of diffusion equations for determining the distribution of moisture within a solid during drying.

JAMES J. HIGGINS, Member TAPPI; Graduate Student, The Institute of Paper Chemistry, Appleton, Wis. Present address: Ohio Boxboard Co., Rittman, Ohio.

McCready and McCabe (*9*) made an extensive study of the air drying of kraft pulp. They determined the moisture distribution during the air drying of pads of pulp approximately 0.3 inch in thickness. From these curves they formulated two mechanisms for the drying of pulp: first, the evaporation of water at the surface as long as the free water moves to the surface sufficiently rapidly to maintain a film of water at that point and, second, the evaporation of water in the interior of the solid as the rate of movement of free water falls below this required rate.

It was the primary object of this study to determine the distribution of moisture within the paper sheet during drying (employing sheets much thinner than those used by McCready) and to study the mechanism by which moisture moves through the sheet.

EXPERIMENTAL EQUIPMENT AND GENERAL PROCEDURES

Equipment

The drying studies were carried out in a recycling tunnel-type drier, shown diagrammatically in Fig. 1. The 12 by 12-inch duct work was constructed from 20-gage galvanized iron soldered at all joints and insulated with 1-inch corrugated asbestos board. Air was circulated by a blower mounted in the duct.

The temperature was maintained within 0.25°F. by using a Cenco DeKhotinsky thermoregulator which operated a relay controlling the current to two 600-watt, 110-volt heaters.

The humidity of the air within the drier was regulated by steam injection. The amount introduced was controlled by one of a number of electric hygrometers (*10*) operating through an a.c. bridge (*11*) with several relays. The wet-bulb temperature was controlled to within 0.25°F. by this method. Provision for air dehumidification was also made in building the apparatus but it was found unnecessary.

An Alnor Velometer, placed within the duct at the sample location, measured the velocity of the air past

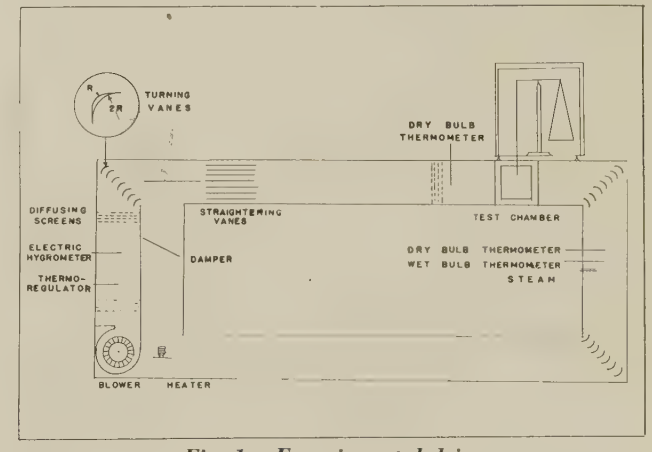

Fig. 1. Experimental drier

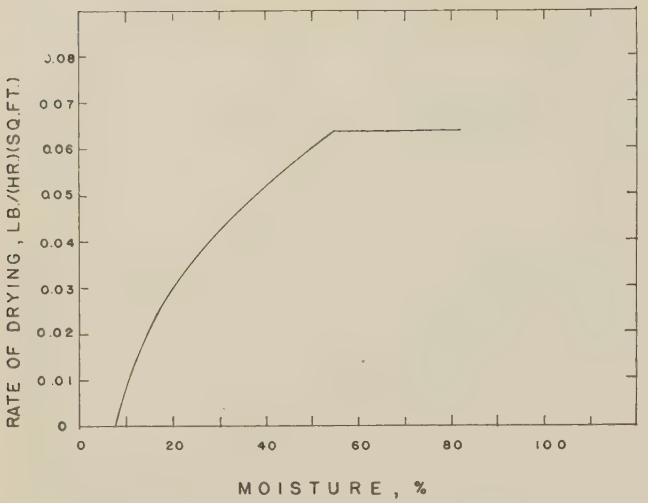

Fig. 2. Typical rate of drying curve

Conditions: dry bulb temperature 110°F.; wet bulb temperature 92°F.; air velocity 310 f.p.m.; basis weight 100 lb.; freeness 500 ml. S.-R.

the sample. Air velocities so measured were accurate to within 10% of the true value.

An analytical balance was mounted on top of the drier in such a manner that the sheet being dried could be suspended from one arm of the balance. Thus, the sheet weight could be determined at any time during a drying test. Although provision was made for bypassing the air stream during a weighing, a study of the effect of air movement on the accuracy of weighing indicated a maximum variation of 20 mg. in the weight of a 3-gram sheet when weighed with or without air movement. On this basis, weighings were made without interrupting the flow of air.

General Procedures

All studies were made on sheets prepared from commercial rag half-stock which was refined in a laboratory Valley beater according to the TAPPI Standard (*12*). The sheets were prepared on the Noble and Wood sheetmaking equipment (*13*) and pressed on a wringer-type press with a nip pressure of 120 pounds per lineal inch. Multi-ply sheets were made by forming the various plies separately in the sheetmaking equipment and then placing them together before they were passed through the press. Sheets were made containing from one to five plies but, in all cases, the final sheet had a basis weight of 100 pounds (25 × 40—500) and a thickness of approximately 0.010 inch.

The test sheets were cut into 6 by 6-inch samples and the moisture content was adjusted to the desired value. All moisture contents are expressed on the dry basis (gram water per 100-gram oven-dry fiber).

Over-all drying rates were determined by suspending a sheet in the drier, and drying with air at controlled temperature, humidity, and velocity. Vaned sample holders were found necessary to maintain the sheet surface alignment parallel to the direction of the flowing air. The weight of the sample during drying was recorded and a weight-versus-time curve was drawn. The rate of drying was determined by differentiating this curve and the rate was plotted against the average moisture content of the sheet.

The temperature at various positions in the sheet was obtained by using thermocouples mounted within the sheet between the plies. Thermocouples were made from 0.001-inch Alumel and Chromel P wire, and were used in conjunction with a Leeds and Northrup student potentiometer.

OVER-ALL DRYING RATE STUDIES

Inasmuch as a sheet of paper may vary considerably in internal structure depending upon the condition of the furnish and the method of preparation, a number of preliminary studies were made to determine the effect of these variations upon the rate of drying. The usual rate-of-drying versus percentage-moisture curves were used for this comparison, although this method has a number of limitations, especially during the falling rate period, as discussed below. A typical rate-of-drying curve is shown in Fig. 2.

Effect of Freeness

In order to determine the effect of freeness on the rate of drying, sheets prepared from pulps beaten to 275, 500, and 750-ml. Schopper-Riegler freeness were dried under an arbitrary set of conditions. A comparison of the rate-of-drying curves for these sheets and conditions indicated that there was little effect of stock freeness in the constant rate period or in the falling rate period.

Effect of Formation

In another study sheets of varying degrees of formation (uniformity of sheet structure) were dried. The rate-of-drying curves indicated that the rate was independent of the formation, over the range of formation pertinent to this study.

Effect of Air Velocity on the Heat and Mass Transfer Coefficients

Data from the over-all drying rate studies were used to calculate the effective heat and mass transfer coefficients between the air and the sheet.

The coefficient of heat transfer was calculated during the constant rate period using the following equation (the terms are defined in Table I):

$$r(dw/d\theta) = hA(t_a - t_s)$$

Since it was not possible to measure the sheet surface temperature at the time these runs were made, it was assumed that the surface was at the wet bulb temperature of the air. The heat transfer coefficient was

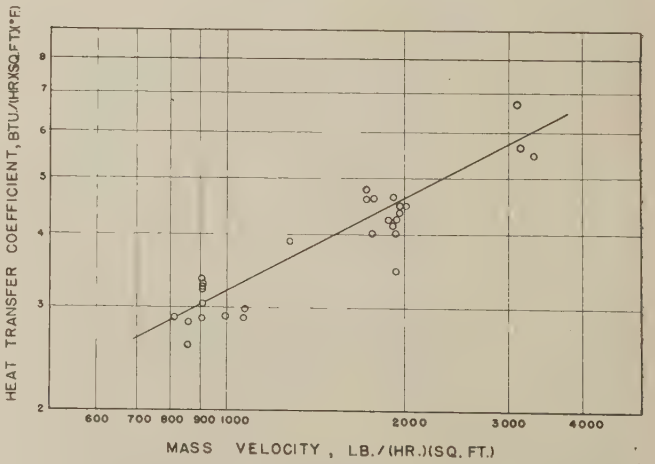

Fig. 3. Effect of mass velocity on the heat transfer coefficient

plotted against the mass velocity of the air on logarithmic paper and the best straight line through these points was constructed by the method of least squares (see Fig. 3). The correlation coefficient for this line is 0.93, and the equation is:

$$h = 0.0903G^{0.46} \quad (800 < G < 3300)$$

The coefficient of mass transfer was also calculated during the constant rate period in an analogous manner, assuming that the air humidity at the sheet surface was the humidity of saturated air at the wet bulb temperature. A plot, similar to Fig. 3, was also obtained and the best line was drawn through the points. The correlation coefficient for this line is 0.85, and the equation is:

$$K = 0.613G^{0.49} \quad (800 < G < 3300)$$

It is noted from the equations that the exponents of the mass velocity are not equal in both equations. The difference is small and is well within the experimental error of measurement. It appears that the heat and mass transfer coefficients vary approximately as the square root of the mass velocity.

These data indicate that drying was occurring through a laminar boundary layer along the surface of the sheet. This is in agreement with the results of Maisel and Sherwood (*14*) for the flow of air over a flat plate. They found that the transition from laminar to turbulent flow in the boundary layer occurred at a length Reynolds number ($1G/\mu$) of several hundred thousand. The length Reynolds number for the present experiments varied between 10,000 and 40,000 and, therefore, the values were well below the critical value. Maisel and Sherwood also found that the mass transfer coefficient varied as the square root of the mass velocity in the laminar region.

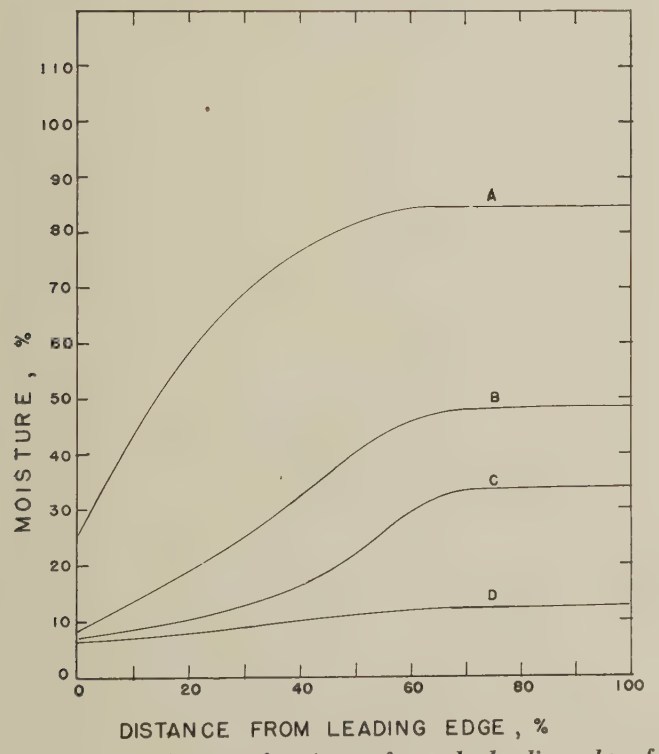

Fig. 4. Distribution of moisture from the leading edge of the sheet

Conditions: temperature 110°F.; relative humidity 50%; air velocity 220 f.p.m.; basis weight 100 lb.; initial moisture 120%. Legend: A—600 sec.; B—900 sec.; C—1200 sec.; D—1620 sec.

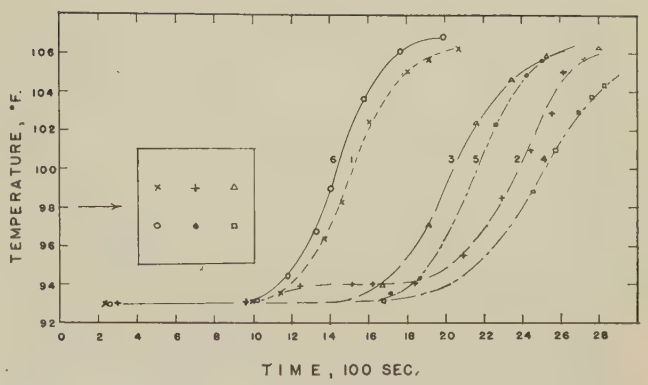

Fig. 5. Temperature of the sheet at various positions during drying

Conditions: temperature 110°F.; relative humidity 50%; air velocity 220 f.p.m.; basis weight 100 lb.; initial moisture 120%.

VARIATIONS IN DRYING RATE OVER SAMPLE AREA

As indicated above, the results thus far presented were calculated from the weight-time relation for the entire sample, and represent average values for the sheet as a whole. Before proceeding to a study of moisture distribution through the sheet, it was considered necessary to investigate the variation in drying rate over the sample area. In one study, a number of sheets were prepared and conditioned for approximately 3 days; they were then dried individually for varying periods of time. When the sheets were taken from the drier they were cut into a number of vertical strips, after which the moisture content of each strip was determined. The results of one typical test are shown in Fig. 4. It is obvious that the rate of drying varies considerably from the leading to the trailing edge.

Further, to check these findings, a study of the temperature of the sheet during drying was made. Figure 5 shows the temperature during drying at the midplane of the sheet at six different positions. As would be expected from the moisture distribution curves previously obtained, the temperature increased first near the leading edge and, as drying continued, near the middle and at the trailing edge of the sheet. Although these temperature data are not entirely consistent, they

Table I. Notations

A	=	area, sq. ft.
c_p	=	heat capacity at constant pressure, B.t.u./(lb.) (°F.)
G	=	mass velocity of air, lb./(hr.) (sq. ft.)
h	=	heat transfer coefficient, B.t.u./(hr.) (sq. ft.) (°F.)
H	=	absolute humidity, lb. of water/lb. of air
		H_a of air
		H_s of saturated air at sheet surface
k	=	thermal conductivity, B.t.u./(hr.) (sq. ft.) (°F./ft.)
K	=	mass transfer coefficient, lb./(hr.) (sq. ft.) (unit ΔH)
l	=	length of sheet being dried, ft.
M	=	moisture, g.
P	=	capillary pressure, dynes/sq. cm.
r	=	latent heat of evaporation of water, B.t.u./lb.
R	=	radius, cm.
SR	=	freeness, ml., Schopper-Riegler
t	=	temperature, °F.
		t_a of air
		t_s of sheet surface
μ	=	viscosity, lb./(hr.) (ft.)
w	=	weight of sheet, g. or lb.
θ	=	time, hr.
σ	=	surface tension, dynes/cm.

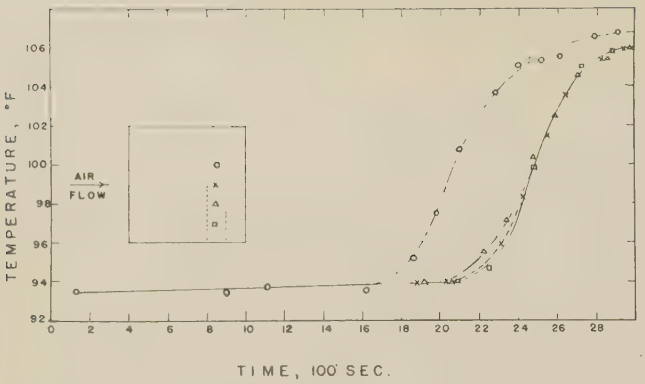

Fig. 6. Temperature of the sheet during drying

Conditions: dry bulb temperature 110°F.; wet bulb temperature 92°F.; basis weight 100 lb.; freeness 500 ml. S.-R.; air velocity 220 f.p.m.

indicate again the lack of uniformity in drying rate over the sample area.

These results suggest that the typical drying rate curve, determined on a small sample, should be interpreted with care. Since drying rate and moisture content are averages for the whole sample, the "critical moisture content" and inception of the "falling rate period" probably occur while much of the sheet is still drying at constant rate. Variations in drying characteristics during the falling-rate period may be much more dependent upon drying conditions than upon the character of the material being dried. However, it appears that identical drying curves would indicate that any variation in drying characteristics is small.

For studies of moisture distribution through the sheet it was considered necessary to select a small portion of the sample which was drying more or less uniformly. From Fig. 4 it was apparent that the trailing 2 inches were apparently drying uniformly; therefore, a section 1 by 3 inches was selected as shown in Fig. 6. In an attempt to check the uniformity of drying of this section, a two-ply sheet with thermocouples embedded at the midplane at various positions was dried, and the temperature was measured during the drying. Figure 6 shows that, within the sample area, the temperature was nearly uniform during the drying period.

MOISTURE DISTRIBUTION THROUGH THE SHEET DURING DRYING

The moisture distribution through the sheet was determined using sets of two-ply sheets, prepared as outlined previously, so that the basis weights of the plies were as follows:

90 lb.—10 lb.	70 lb.—30 lb.
85 lb.—15 lb.	65 lb.—35 lb.
80 lb.—20 lb.	60 lb.—40 lb.
75 lb.—25 lb.	55 lb.—45 lb.

The sheets were conditioned to the desired moisture content for at least 72 hours, and then dried individually to a predetermined weight. Immediately after each sheet was removed from the drier, the desired 1 by 3-inch section was cut from the sheet, the plies were separated, and the pieces dropped into weighing bottles. The entire operation from the removal of the sample until the weighing bottle was covered required from 10 to 15 seconds. The separated plies were exposed to evaporation for about 2 or 3 seconds before they were placed in the bottle. Studies on the effect of handling indicated that the error introduced was less than 3% of the moisture present.

The total percentage moisture in each sheet was then calculated from the moisture data of the various plies. Since the moisture contents and the section sizes varied slightly, it was necessary to adjust the data to the same sample size and to the average percentage moisture of the run. A sample calculation is given in Table II.

Table II. Sample Calculation of the Transverse Moisture Distribution (Run I)

1 Dry weight of thinner ply, % (of sheet)	*2 Moisture in thinner ply, %*	*3 Total moisture, %*	*4 Moisture in thinner ply[a] (corrected to average moisture), %*	*5 Moisture in thinner ply,[b] g./g. of oven-dry stock*
11.1	52.3	80.0	54.3	0.0603
15.2	64.9	83.2	64.8	0.0984
20.9	67.5	79.1	70.8	0.1480
24.6	75.0	84.0	74.1	0.1822
31.5	79.3	84.8	77.6	0.2444
34.5	79.9	85.2	78.0	0.2688
40.2	83.0	85.5	80.5	0.3240
44.8	82.5	84.1	81.5	0.3644

[a] Column 4 = column 2 × average total moisture divided by column 3.
[b] Column 5 = column 1 × column 4.

The weight of the moisture in the thinner ply (column 5) was plotted against its percentage weight (column 1) which corresponds to its distance from the surface of the sheet. The moisture distribution could then be determined, since the slope of this line, at any point, is the percentage moisture content of the sheet at that point. The reproducibility of this method, as indicated by the results of duplicate runs, was excellent.

To determine whether or not the results obtained by

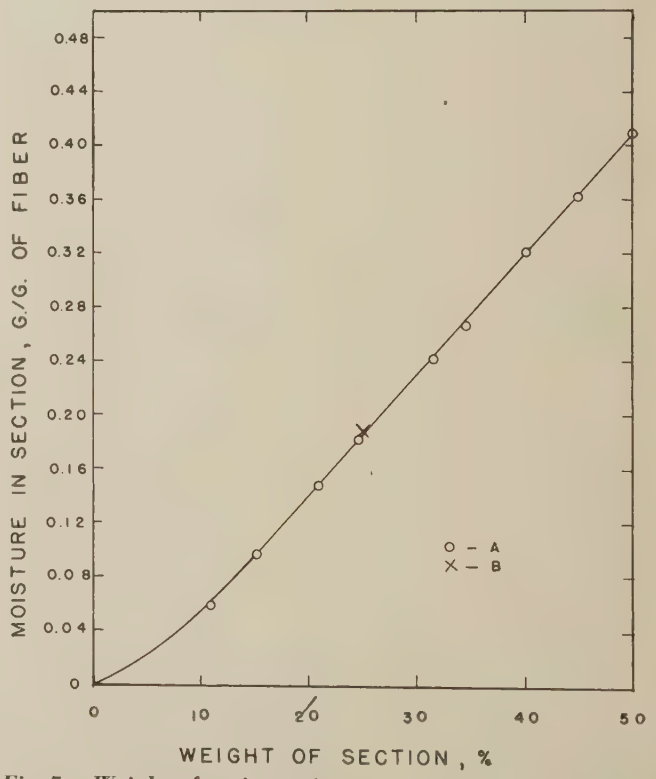

Fig. 7. Weight of moisture in various sections of the sheet

Conditions: dry bulb temperature 110°F.; wet bulb temperature 92°F.; air velocity 220 f.p.m.; basis weight 100 lb.; freeness 500 ml. S.-R. Legend: A—two-ply sheets; B—single-ply sheet.

this method are applicable to single-ply sheets, similar experiments were conducted with single-ply sheets. Each sheet was dried for a given time, removed from the drier, and the sheet split into two sections. The moisture content of each section was determined in the same manner as for the two-ply sheets. The thicknesses of the dry sections were then determined at several positions, in order to check the uniformity of the separation. The uneven sections were discarded and the data from the acceptable runs were plotted together with those obtained for the two-ply sheets. Figure 7 is a good example of the agreement obtained for single and two-ply sheets.

Variation in Moisture Distribution During Drying

In order to study the movement of the moisture within the sheet of paper during air drying, the distribution of the moisture was determined at several stages of drying, using the above-described technique.

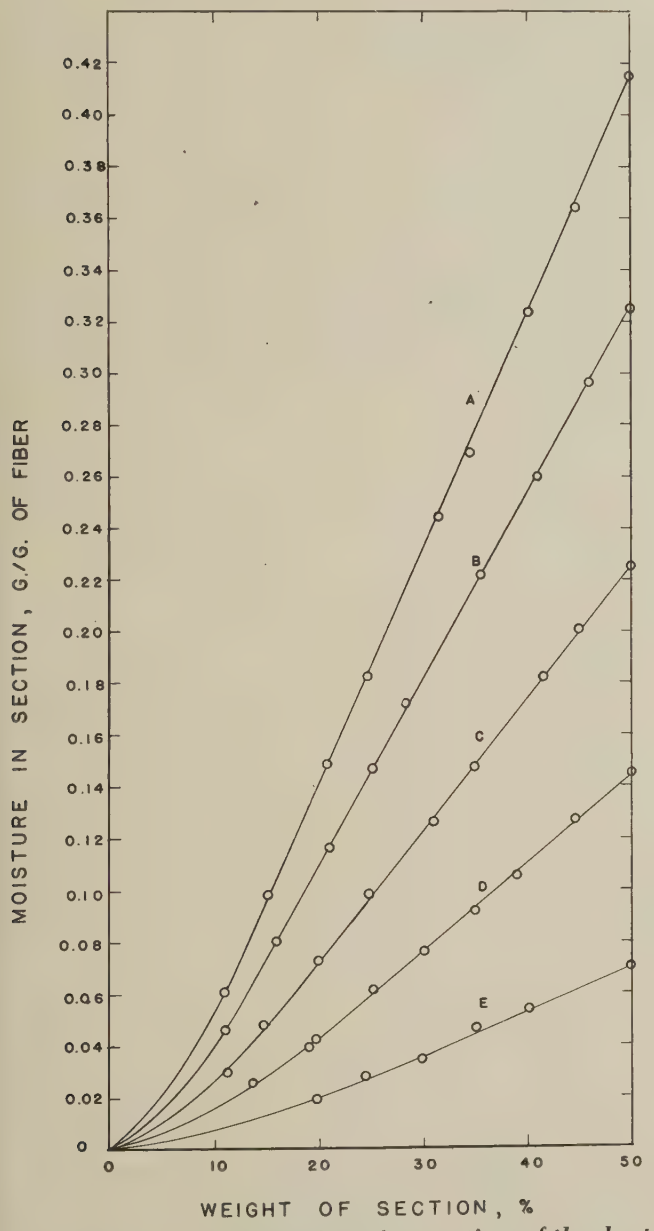

Fig. 8. Weight of moisture in various sections of the sheet

Conditions: dry bulb temperature 110°F.; wet bulb temperature 92°F.; air velocity 220 f.p.m.; basis weight 100 lb.; freeness 500 ml. S.-R. Legend: A—590 sec.; B—870 sec.; C—1190 sec.; D—1450 sec.; E—1720 sec.

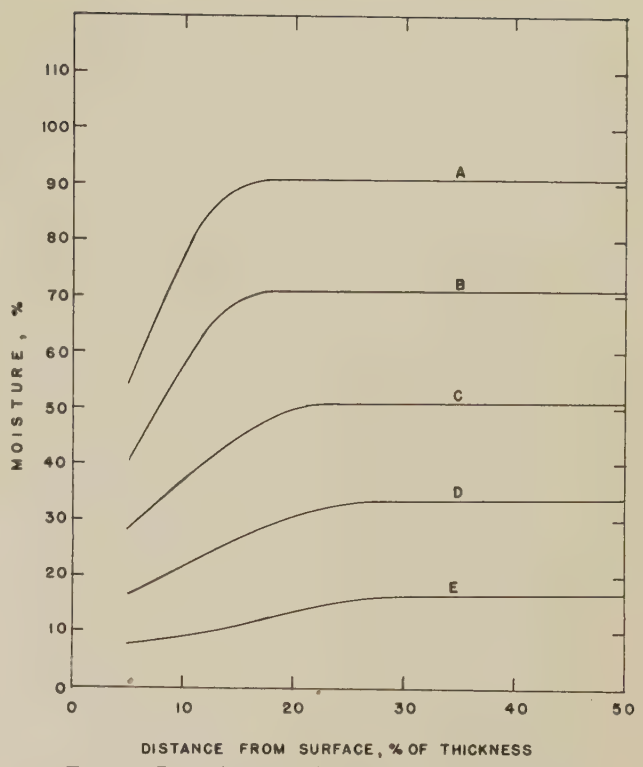

Fig. 9. Distribution of moisture during drying

Conditions: dry bulb temperature 110°F.; wet bulb temperature 92°F.; air velocity 220 f.p.m.; basis weight 100 lb.; freeness 500 ml. S.-R. Legend: A—590 sec., 83% average moisture; B—870 sec., 65% average moisture; C—1190 sec., 45% average moisture; D—1450 sec., 29% average moisture; E—1720 sec., 14% average moisture.

Figure 8 shows the weight of moisture in the thinner section versus the percentage weight of the section, and indicates the drying conditions. From these curves the moisture distribution at five intervals during the drying period was obtained (Fig. 9).

These data indicate that there is a continual decrease in the moisture content at all points in the sheet as the drying continues. It is further noted that the central portion of the sheet possesses a uniform moisture concentration and, as the moisture content decreases, the uniform moisture section within the sheet becomes thinner and thinner.

Effect of Variation in the Freeness of the Sheet

In an attempt to vary the internal resistance of the sheet to passage of air, water, and water vapor, a study of the effect of stock freeness was made.

A number of sets of sheets were prepared by the standard method and, as before, each set of sheets was dried under identical drying conditions but for varying periods of time. The moisture distribution at each interval was determined; typical results are shown in Fig. 10. Although there may be some effect of freeness on the moisture distributions, the effect appears to be minor. This conclusion is in agreement with the previous result on the effect of freeness, as determined by means of over-all rate-of-drying studies.

Effect of Initial Moisture Content

In the preceding studies, the moisture distributions were determined for sheets dried from the same initial moisture content. To study the effect of initial mois-

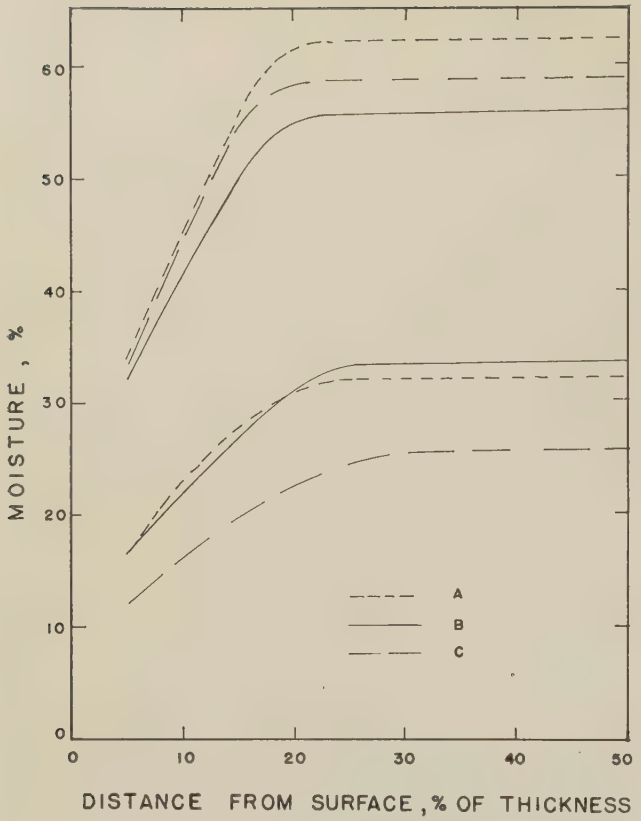

Fig. 10. Effect of freeness on the distribution of moisture

Conditions: dry bulb temperature 110°F.; wet bulb temperature 92°F.; air velocity 220 f.p.m.; basis weight 100 lb. Legend: A—freeness 275 ml. S.-R.; 1032 sec., 55% moisture; 1449 sec., 27½% moisture. B—freeness 500 ml. S.-R.; 1100 sec., 50% moisture; 1450 sec., 29% moisture. C—freeness 750 ml. S.-R.; 1062 sec., 53% moisture; 1540 sec., 22% moisture.

ture content, a number of sets of sheets were prepared in the standard manner, using stock having a Schopper-Riegler freeness of 500 ml. Four sets were then adjusted and conditioned at 80% moisture, four sets at 50% moisture, and one set at 30% moisture. The distribution of moisture through the sheets was determined at several stages of drying.

Figure 11 shows the results obtained at average moisture contents of 50% and 30%. At any moisture content, the samples which had a lower initial moisture content appear to possess a thicker section within which the moisture content is uniform. This difference decreases as the drying continues.

Effect of Variations in the Rate of Drying

An increased rate of drying can be obtained by a number of methods, among them (1) by increasing the temperature of the air, (2) by decreasing the humidity of the air, and (3) by increasing the air velocity. The third method was decided upon for studying the effect of drying rate since, by this method, the sheet temperature and the equilibrium moisture content of the sheet were the same regardless of the rate. Furthermore, the viscosity and vapor pressure of the moisture within the sheet remained the same at the higher rate of drying.

The moisture distributions at various stages during the drying are similar to those previously obtained. Figure 12 shows the data obtained with an air velocity of 400 feet per minute. To permit a closer comparison, the distributions are replotted at 50% total moisture in Fig. 13. From these curves it can be seen that, as the rate of drying is increased, the trend is for a decrease in the thickness of the region of uniform moisture. In general, this deviation is very slight and is within the limits of experimental error.

DISCUSSION

It appears from the results which have been presented that, under the conditions employed, drying was controlled largely by the air boundary layer—that is, by the rates of heat and mass transfer between the air and the sheet. Marked changes in the internal structure of the sheet had a negligible effect on the drying rate or the moisture distribution through the sheet, and significant changes in drying rate had little effect on the moisture distribution. This is probably largely a consequence of the thickness of the sheets which were used. Every effort was made to work with the thinnest sheets possible, in order to approach the situation which actually exists in most paper drying. The thickness employed (approximately 0.01 inch), while still thicker than most papers was considerably less than those employed by other investigators.

The drying rates employed were in the range normally used in air drying, but were much lower than the rates obtained in the machine drying of paper. This factor also helped to make possible the control of the operation by the boundary layer.

Previous work on the moisture distribution through the paper sheet during air drying is meager, the most pertinent study being that of McCready and McCabe (9).

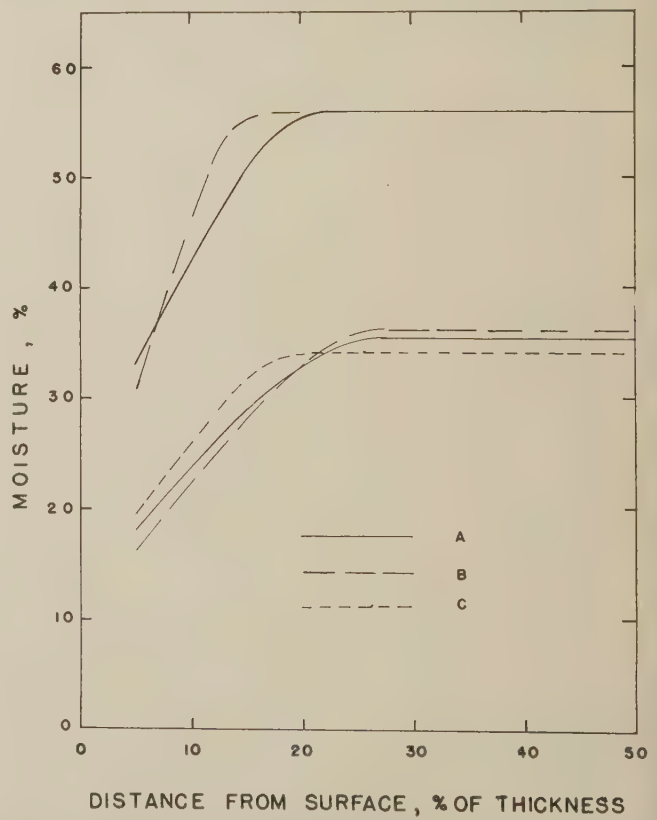

Fig. 11. Effect of initial moisture content on the distribution of moisture

Conditions: dry bulb temperature 110°F.; wet bulb temperature 92°F.; air velocity 220 f.p.m.; basis weight 100 lb.; freeness 500 ml. S.-R. Legend: A—initial moisture 120%; B—initial moisture 80%; C—initial moisture 50%.

They employed pads prepared from kraft pulp, at various thicknesses from 0.04 to 0.90 inch (their moisture distribution studies were on pads about 0.3 inch thick). In general, they found much more dependence of drying rate upon the internal characteristics of the pad than was found during the present investigation. It is worthy of note that the behavior of their thinnest pads approached most closely the behavior of the sheets used in this study. In general, it seems evident that the effect of sheet variables upon the over-all drying rate and upon the moisture distribution within the sheet becomes less as the sheet thickness is reduced.

It has been well established by numerous workers that the "critical moisture content" (the moisture content at which the constant rate period ends and the falling rate period begins) is a function not only of the material being dried, but also of the drying conditions and the drying rate. It was suggested earlier in this paper that the critical moisture content observed in the over-all drying rate studies should be interpreted with caution. Under the conditions which existed at the 1 by 3-inch sample of the sheet used for the moisture distribution studies, it appears that most of the drying should have been at constant rate and that the critical moisture content should have been very low. This is borne out by analysis of the data obtained, which indicate no decrease in drying rate until the moisture content has fallen to 20 to 30% on the dry basis. This is in the range of, and in some cases may be below, the fiber saturation point (the point below which moisture present in the sheet exerts a vapor pressure lower than that of pure water). Thus it appears that all of the "free water," and possibly some of the "bound water," in the sheet was able to move to the surface at a rate sufficient to maintain the surface evaporation rate at its maximum value. Because of the levels of moisture content and the general shape of the moisture distribution curves, it is believed that this internal movement of water was largely brought about by capillary forces. During the last stages of drying, the shape of the moisture distribution curves suggests that internal vaporization of water was occurring.

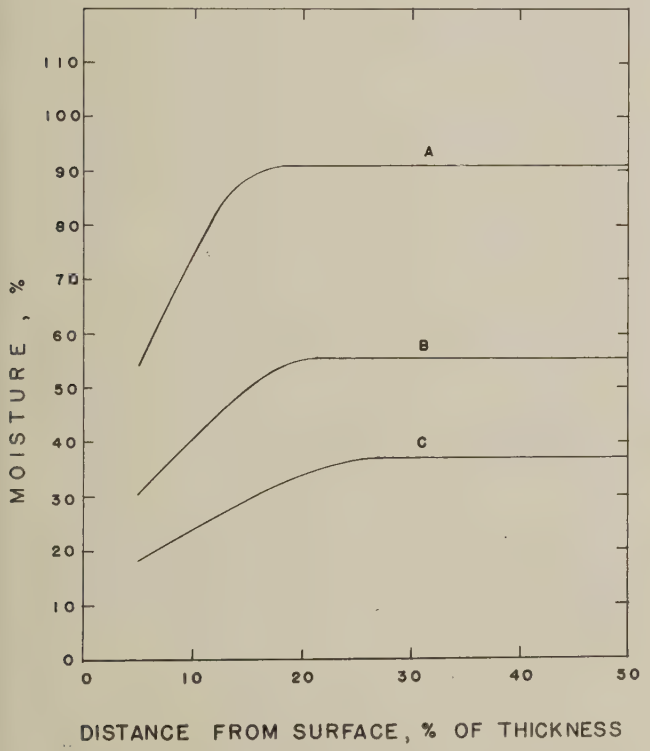

Fig. 12. Distribution of moisture during drying

Conditions: dry bulb temperature 110°F.; wet bulb temperature 92°F.; air velocity 400 f.p.m.; basis weight 100 lb.; freeness 500 ml. S.-R. Legend: A—343 sec., 83% moisture; B—572 sec., 50% moisture; C—829 sec., 31% moisture.

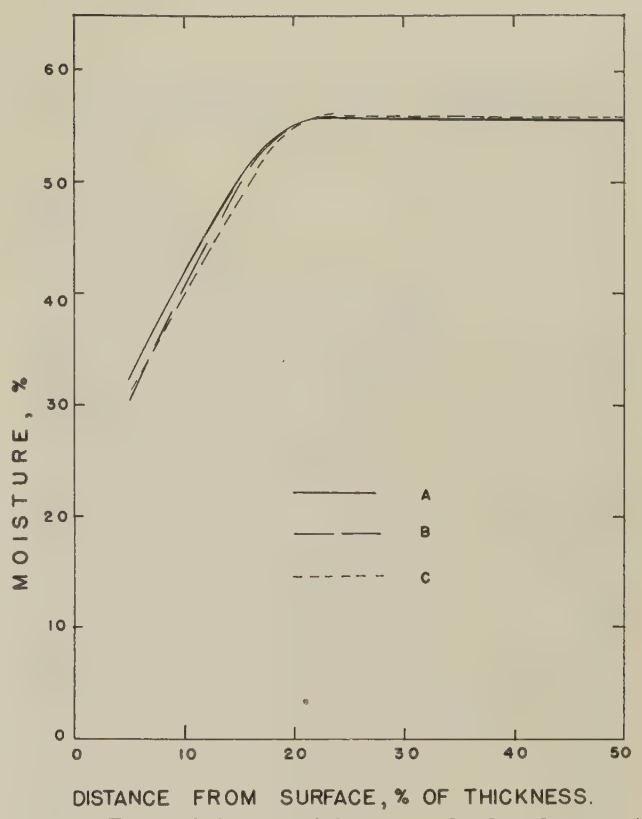

Fig. 13. Effect of the rate of drying on the distribution of moisture

Conditions: dry bulb temperature 110°F.; wet bulb temperature 92°F.; basis weight 100 lb.; freeness 500 ml. S.-R. Legend: A—air velocity 220 f.p.m.; B—air velocity 400 f.p.m.; C—air velocity 600 f.p.m.

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Woodmill Log Handling in the Pulp and Paper Industry on the West Coast

W. H. RAMBO and H. A. DeRICE

This paper gives and illustrates the most modern and up-to-date log handling devices in woodmills on the West Coast. Illustrated and described are the most modern log hauls, log transfers, roll conveyors, log loading and handling equipment, and band mill installations. The paper also illustrates and touches on hydraulic barking and chipping of whole logs and small wood handling. The paper throughout deals with actual, new installations, some of which have never been published before, which are operating profitably every day.

WHEN the assignment of preparing a paper on woodmill log handling in the pulp and paper industry on the West Coast was accepted, it was a difficult problem deciding what would be the most interesting practices to other engineers. It was finally decided to present the most modern, up-to-date conveyor installations, transfer mechanisms, and log handling devices that are used at various mills throughout the West Coast.

A typical West Coast woodmill and how it operates will be considered and, insofar as possible, how it is built. But, first a word as to the wood to be handled in western mills.

As all know, deck loads of logs 8 to 60 inches in diameter are common in West Coast operations. These logs are brought from the woods in lengths varying from 24 to 60 feet or more. Ten years ago, in the era of lower labor costs, these logs were usually reasonably well trimmed of limbs in the woods, today, it is not impossible to find the stub of a limb 7 inches in diameter projecting 30 inches from the surface of the log as it enters the woodmill. With increasing timber costs the pulp operator more and more is sorting his logs and selling all of the higher grades to a lumber or plywood manufacturer leaving only the lower grade logs for the use of the woodmill. All of which is mentioned to point out that, although a major part of a woodmill's operation is a material handling problem, it is handling the most nonuniform material in the world. To the woodmill designer a log may be of any shape or size.

The introduction of hydraulic whole log barking in the woodmills of the West Coast during the past 10 years has brought revolutionary changes in woodmill design. A whole log hydraulic barking and chipping installation involves a minimum investment approaching a million dollars. Such an expenditure, together with the vibration and impact problems that accompany the rapid rotation or traverse of tremendous masses and the high-moisture condition existing in a barking plant, demands the use of a structural frame of greater rigidity and permanence than that provided by the traditional wooden building. Since 1945, almost without exception, every major woodmill built on the West Coast has been of steel and concrete construction.

The steel and concrete woodmill requires a much greater amount of detailed engineering; the location of every bearing, every sprocket, and every shaft must be known and fixed on the drafting board before the structural steel frame can be fabricated. Conversely, since the structural frame is prefabricated and erected ready to receive machinery equipment installation costs are much lower. Millwrighting skill has been largely transferred to the drafting board and fabricating shop; field construction becomes primarily a matter of assembly and adjustment.

In the design of the woodmill of the Soundview Pulp Co. in 1945, the first West Coast woodmill built entirely of steel and concrete, a pattern of new details, both mechanical and structural, was developed, which, with gradual evolutionary changes, has been widely reused in the design of later plants throughout the industry.

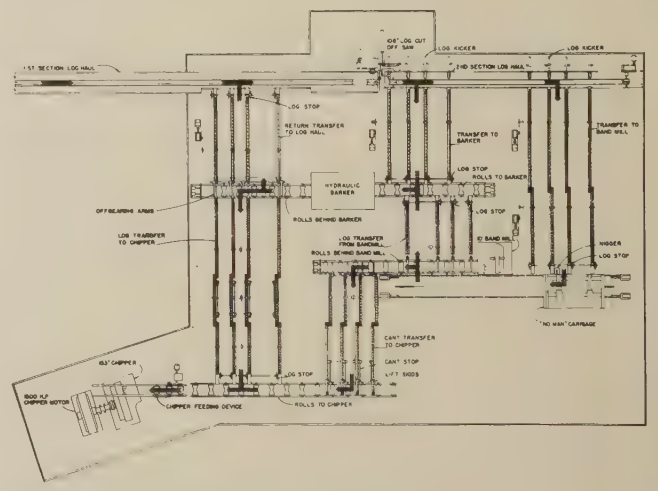

Fig. 1. Machinery floor plan of typical West Coast woodmill

Because of the greater cost of steel construction, together with the higher strength available in steel beam sections, current design has endeavored to reduce to a minimum the duplication of structural parts, thus, transfer skids are self-supporting throughout their length and in addition carry the concrete floors in their lower flanges, floor elevations are not carried at a constant level but vary with the elevations of main structural members required to carry equipment. All machinery floor areas are sloped for drainage toward "clean-up" holes located over the refuse conveyor system for easy waste disposal. The lower floor is

W. N. RAMBO and H. A. DERICE, W. N. Rambo, Industrial Plant Engineer, Portland, Ore.

Fig. 2. Typical West Coast all-steel log haul. Two West Coast mills have built log hauls of reinforced concrete

usually a structural concrete floor carried on a reinforced concrete beam system supported from the main column footings. Conveyors are built entirely of steel plate and structural shapes, the trough being of simplified design formed in 12-foot sections by bending from flat plate.

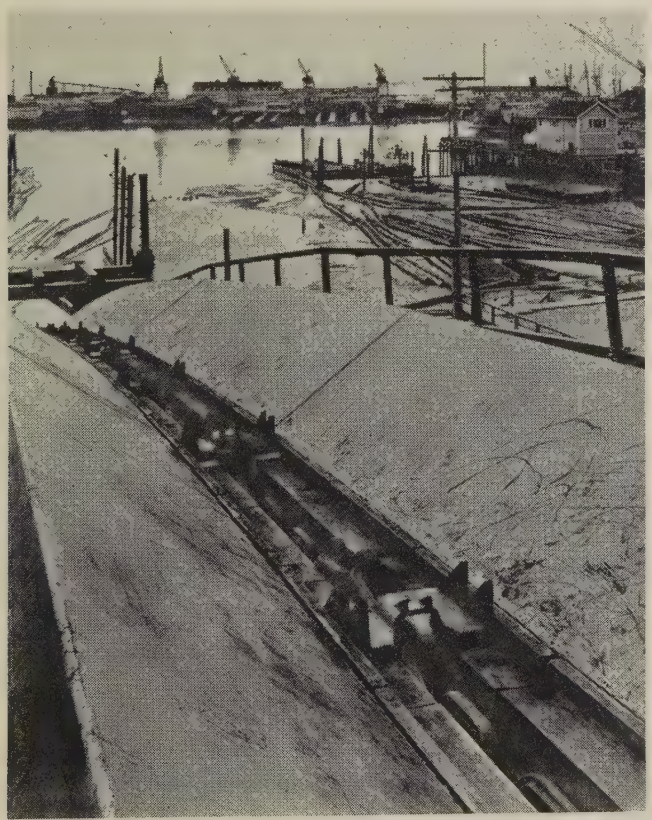

Fig. 3. View looking down log haul trough—typical of steel log haul construction

Woodmill construction in this new medium is still in the process of development. A major problem remaining is that of greater cleanliness. The woodmill of the past, usually a dilapidated wooden building at the rear of the property, was dirty, unpainted, an unwanted "stepchild" of the industry. The modern steel and concrete woodmill, representing an investment sometimes in excess of $2,000,000, attempts to achieve a "good-housekeeping" comparable to that of the bleach plant or machine room. Such cleanliness, of course, is difficult and costly to achieve—even our most recent mills fall far short of what should reasonably be expected.

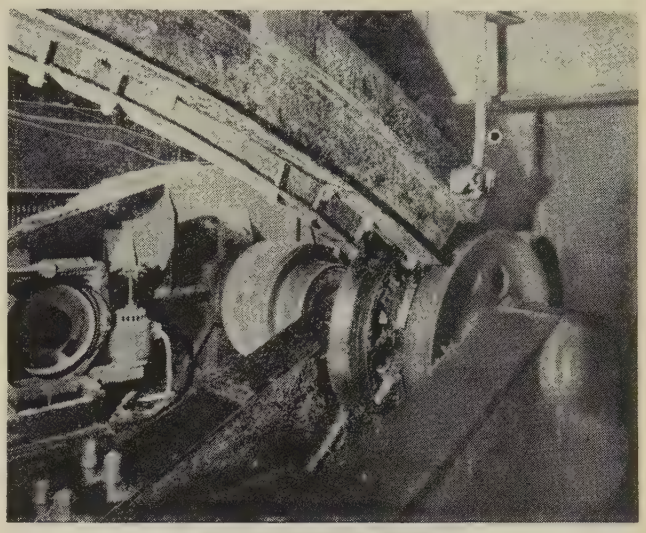

Fig. 4. Close-up of log haul drive

Unit shown has ratio of 80:1 and is driven by 1200 r.p.m., 100-hp. slip ring motor. A seven-tooth round link chain sprocket is directly connected to the extended low-speed shaft.

Figure 1 shows the equipment arrangement of a typical West Coast woodmill. In its operation, logs up to 60 feet in length are brought up the log haul to the cut-off saw and cut to lengths suitable for handling in the mill. This particular plant is designed to handle logs 32 feet in length through all of its operations although the majority of the West Coast woodmills, are designed for lengths of 20 or 24 feet. After cutting to mill length the logs are kicked out of the second section

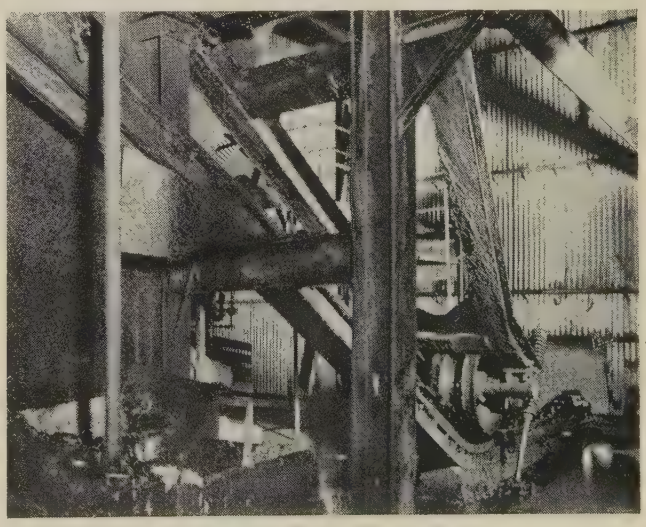

Fig. 5. Hinged idler used on log haul chain return to eliminate surge

log haul onto the transfer to barker and loaded one by one into the V-rolls feeding the hydraulic barker. After passing through the barker, the logs are sorted for diameter by the barker operator, logs under 33

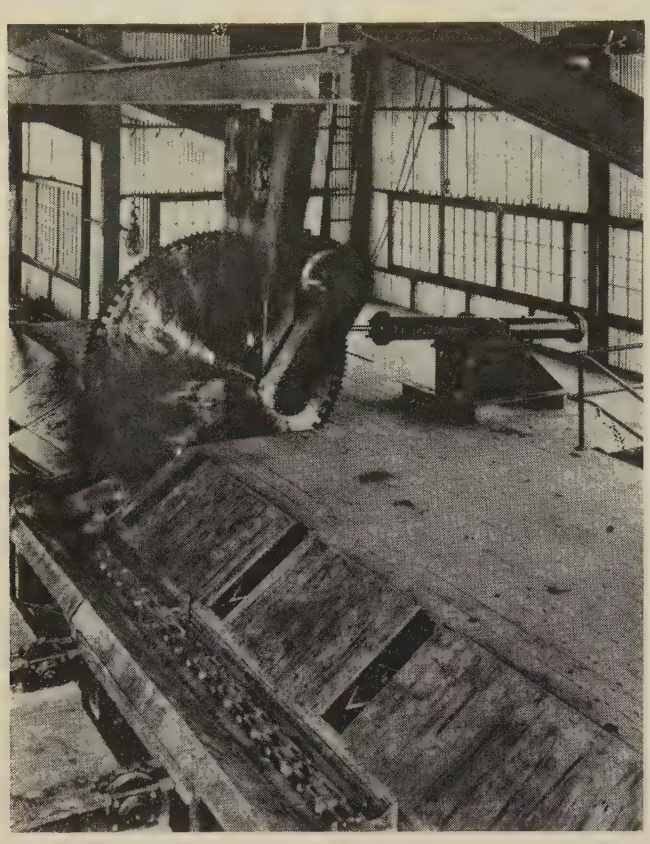

Fig. 6. 108-inch diameter swing log cut-off saw in West Coast woodmill

inches diameter being discharged by lift arms to the transfer to chipper and all oversize logs requiring breakdown discharged by an opposing set of lift arms to the return transfer to log haul. These are returned to the log haul as opportunity permits, conveyed the length of the mill by the log haul, and kicked out onto the transfer to band mill. When sufficient oversize logs are accumulated on this storage transfer, one operator

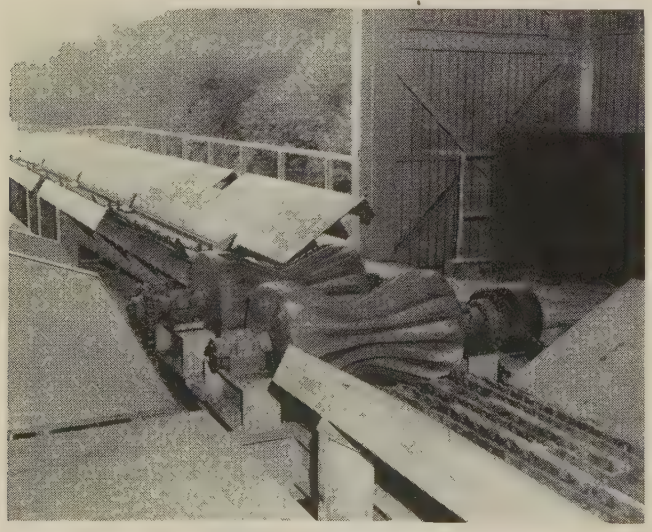

Fig. 7. Twin V-rolls support log at swing cut-off saw

loads them one at a time upon the "no-man" carriage, breaks them down to cants of a suitable size for chipping and transfers them to the cant transfer to chipper. The chipper operator controls the unloading of logs and cants from either of the two transfers to the roll conveyor to chipper.

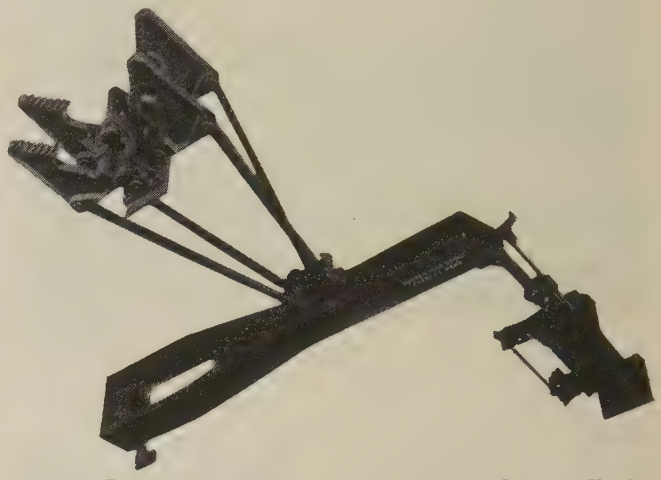

Fig. 8. Log dogging jaws used in many older mills for holding log during cut-off operation

The steel log haul outside of the plant is shown in Fig. 2. This all steel log haul is 150 feet in length, has a maximum lift of 55 feet, and operates at 130 f.p.m. Reinforced concrete log hauls have been built for two of our more recent plants. This is a more expensive construction but offers the advantage of lower maintenance costs to the mill located on salt

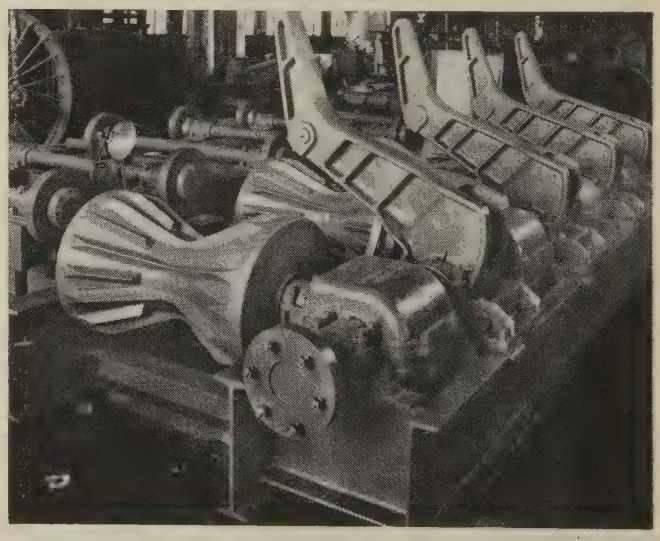

Fig. 9 One-piece cast steel ribbed V-rolls widely used in new West Coast woodmills

water. The wooden log haul structure shown to the right of the main log haul is a log return conveyor used to return barked oversize logs to the pond prior to the installation of the band mill. The housing of the log washer is located on the steel log haul midway up its slope.

The log haul trough in Fig. 3 is typical of steel log haul through construction, The sides are of flat plate stiffened by channels. The chain used is $1^3/_4$ by $2^1/_2$ by 8 inch pitch, manganese, round link chain with steel log chairs running on a cast-iron liner.

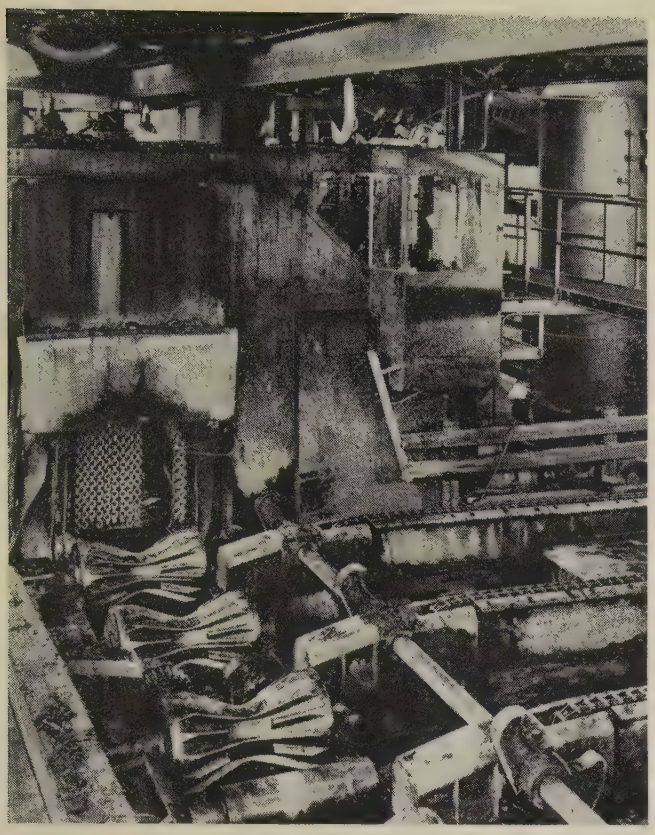

Fig. 10. V-roll case on incoming side of hydraulic log barker

Figure 4 is a close-up of a typical log haul drive arrangement. This reduction unit has a ratio of 80:1 and is driven by a 1200-r.p.m., 100-hp., slip ring motor. A seven-tooth, round link chain sprocket is directly connected to the extended low speed shaft. Several of the more recent installations have two-speed reduction units, arranged to give log haul chain speeds of, perhaps, 90 and 180 f.p.m. It will be noted that the log haul chain ducks down to the drive sprocket relieving the log chairs of load before they pass around the sprocket.

Figure 5 shows a hinged idler used on the log haul chain return to eliminate chain surge and insure proper riding of the chairs on the return guides.

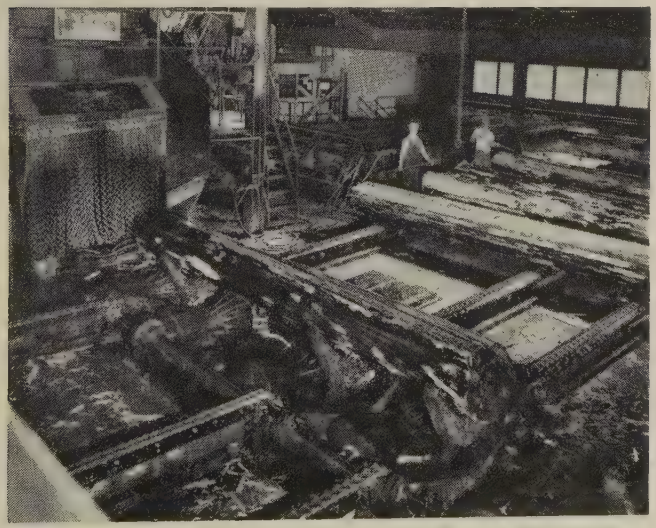

Fig. 11. V-roll case behind hydraulic log barker. Note lift arms used in sorting logs to either of two transfers

Figure 6 is a photograph taken during construction and shows the swing cut-off saw and the log conveyor behind it. The saw is 9 feet in diameter and is driven by a 75-hp. motor. Note that the log is supported and held at the saw by the raised center section of the log haul trough ahead of the saw and by a cast iron V-shaped pillow behind the saw. The photograph also shows the slots through which the punch bars of the log kicker operate to eject the log to the transfer deck.

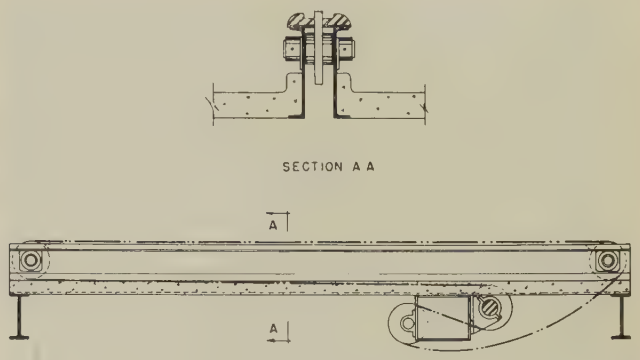

Fig. 12 Drawing showing construction of a typical log transfer

The method of supporting the log at the cut-off saw used in more recent installations is illustrated in Fig. 7. The two chain-driven V-rolls are set at an elevation that will raise the log from 6 to 8 inches above the level of the log conveyor insuring that the log will break away from the swing saw when cut.

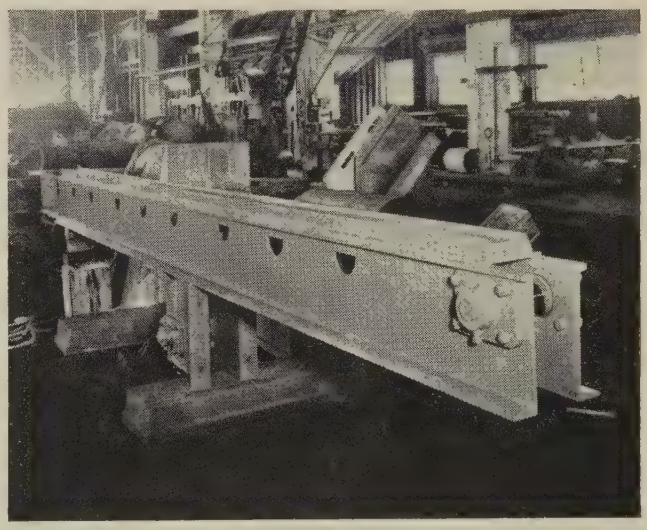

Fig. 13. Shop photograph of transfer skid

Figure 8 shows a mechanism used in many of the older mills for holding the log during the cut-off operation. When the steam cylinder is actuated these log dogging jaws grip and raise the log at either side of the saw line. Their use is justified where many small diameter logs are to be cut to short lengths but necessitates an additional operation, and the equipment requires considerable maintenance.

In addition to the conventional chain log haul or log conveyor shown in the preceding figures, roll conveyors are often used in conveying logs longitudinally. For this purpose a special one-piece cast-steel ribbed V-roll 42 inches long, 26 inches diameter at the

ends, and 15 inches diameter at the center was developed that has become quite standard in the West Coast industry (Fig. 9). V-rolls convey logs quite satisfactorily although the progress of the log is often accompanied by much bumping and vibration. They are more costly than an equivalent chain conveyor and, in general, their use should be restricted to those special applications requiring the use of rolls.

Fig. 14. Log stop and loader at head of log transfer

Figure 10 shows the V-roll case on the incoming side of the hydraulic barker. In this instance, the use of rolls is justified and required by the installation of four trunnion wheels (two of which are shown in the foreground of the photograph) which raise and rotate the logs as required by this barking operat on.

Figure 11 is the roll case behind the hydraulic barker. Note the opposing sets of off-bearing arms used to transfer logs to transfer chains on either side of the roll case. These off-bearing arms are more positive in operation than the conventional log kicker and are generally used where automatic or semiautomatic operation is required. The log transfers shown are typical of the transfer construction of most of the new mills and are illustrated in detail in Fig. 12 which is a

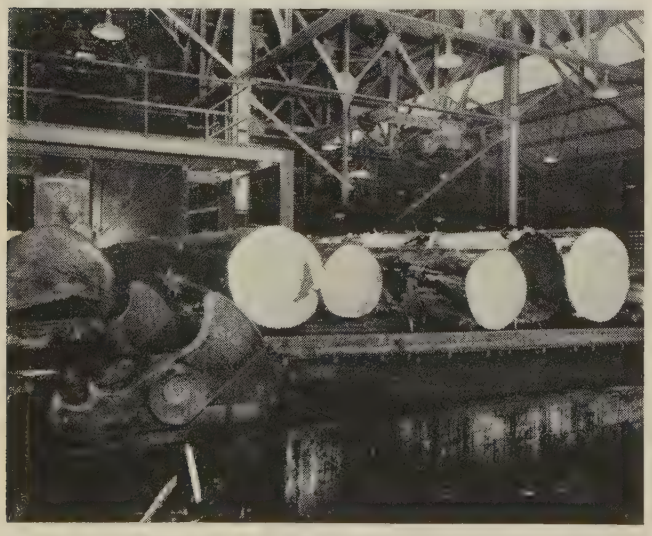

Fig. 15. Log stop and loader in operation, discharging log from transfer while holding back remaining logs on transfer deck

Fig. 16. Simondson log turner turning log on bank mill carriage

sectional drawing showing the construction of a typical log transfer. The transfer skid (Fig. 13) is made up of two channels, placed back to back and separated as required by the width of the chain and sprockets. A cast-iron chainway liner is bolted on their upper surface, and the concrete mill floor is carried in their lower flanges. Head and tail sprockets are mounted between dead-eye boxes in the channel webs, and brackets extend below the skid to carry the drive sprocket and idler required for a wrap drive. Transfer chains used in West Coast mills are commonly H-124, C-132, and SS-124 plus. They are ordinarily driven at 40 to 50 f.p.m.

Fig. 17. Lift skids of special design for use with Simondson log turner in West Coast woodmills

Figure 14 a typical log stop and loader used at the head of a log transfer to discharge logs one at a time to a conveyor, or in this instance, to the band mill.

The log stop and loader in operation are shown in Fig. 15. It will be noted that the hook end, shown in Fig. 14 holding back the logs, has been withdrawn and that the heel of the arm has been raised to kick the first log toward the band mill carriage and at the same time is restraining the remaining logs on the transfer.

Fig. 18. Typical lift skid, Simondson log turner and log deck installation in West Coast woodmill

In the left background is the steel housing around the 10-foot band mill that is standard in western mills.

In loading and turning large logs upon the band mill carriage, a Simondson log turner (Fig. 16) is commonly used. In the photograph the sawyer has cut the first slab from the log and now is engaged in turning the log flat side down before further slabbing. The Simondson hook is engaged in the log and pulls it over on the carriage head blocks until it falls forward and is lowered to the skids by the Simondson arms. The skids are then raised to above the level of the carriage and the log is pushed back upon the carriage by the arms.

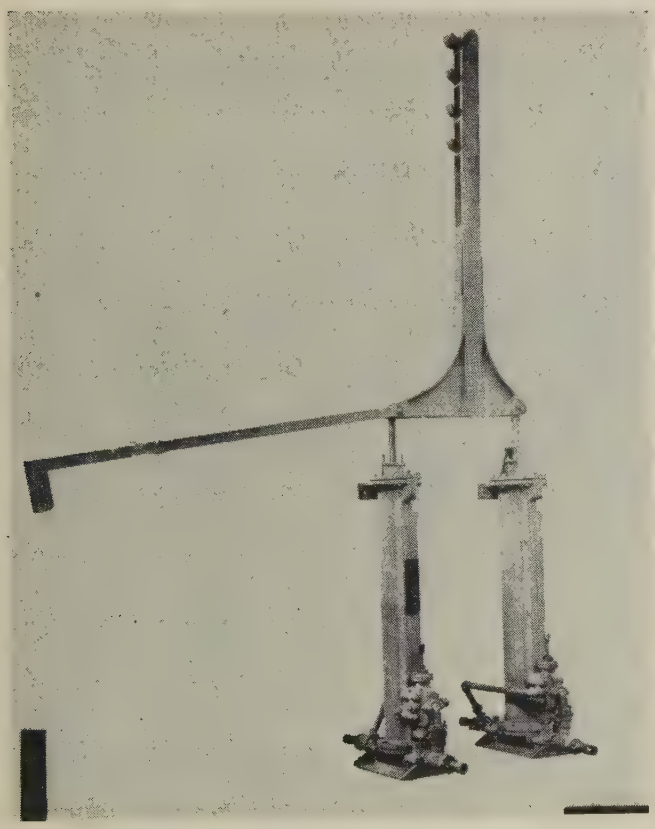

Fig. 19. Hill nigger log turner used in loading and turning smaller logs

A lift skid of new and extremely rugged design for use with the Simondson log turner in the West Coast mills has recently been developed. Figure 17 shows a set of five of these skids awaiting shipment.

Figure 18 shows the lift skid, Simondson log turner, and log deck installation in the recently completed mill of the Crown Zellerbach Corp. at West Linn, Ore.

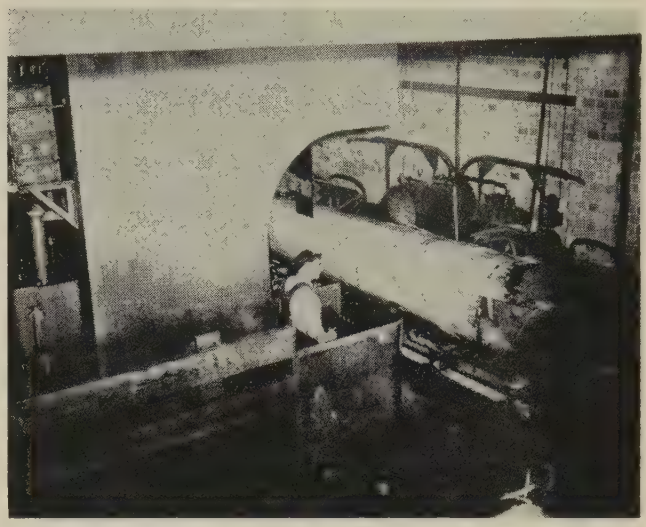

Fig. 20. "No-man" carriage in West Coast woodmill. All operations of loading, dogging, setting, and sawing are controlled by the sawyer

When a large number of smaller logs must be cut on the band mill a steam or air-operated Hill nigger log turner is used instead of the Simondson or as a supplement to it. Figure 19 shows the Hill nigger. Its action is a combination of crowding and lifting that pushes the log against the carriage knees and rotates it in a direction away from the operator.

In the majority of the new wood mills that include the installation of a 150 or 175-inch chipper the number of logs requiring breaking down before chipping is relatively small. Many of these plants have there-

Fig. 21. Cants, cut by the band mill to sizes that will enter the chipper spout, are transferred to rolls leading to chipper

fore installed the "no-man" carriage, similar to that shown in Fig. 20. All of the operations of this carriage are controlled by the sawyer in the foreground, who loads the log, dogs, sets, and saws. The most recent plants include an air-operated "off-bearer" which, under the control of the sawyer, holds the cant against the log as it is sawn and then lowers it to the rolls flat side down.

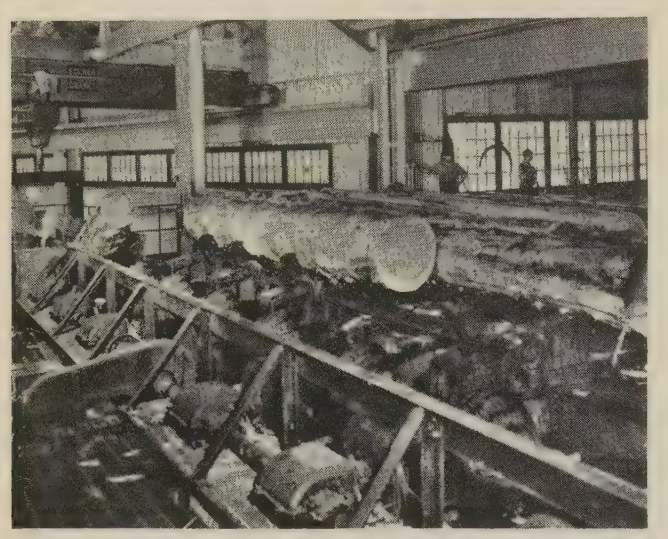

Fig. 22. Head of log transfer from hydraulic log barker and rolls to chipper. In background, log is shown entering chipper spout

After sawing by the band mill to sizes that will enter the chipper spout, the cants are transferred to the roll conveyor to the chipper. Figure 21 shows the detail

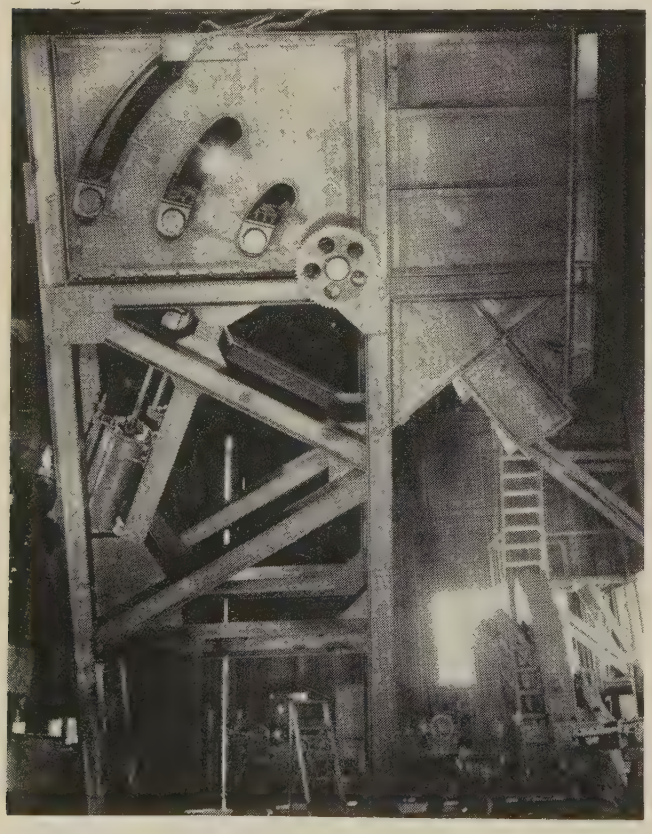

Fig. 23. Shop photograph of assembled chipper feeding device

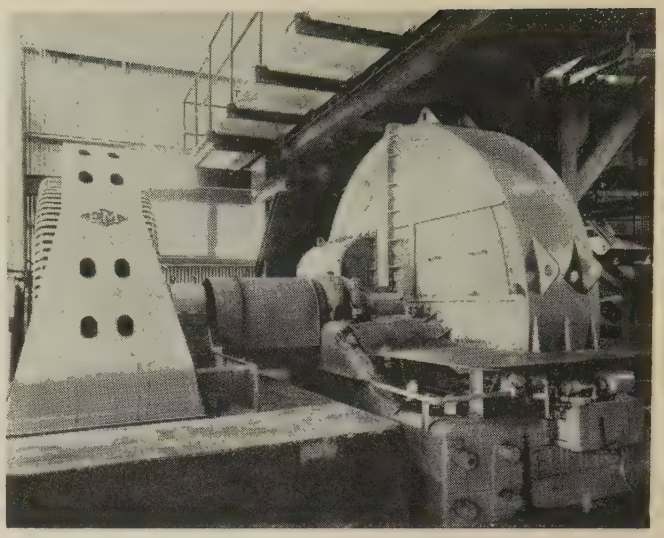

Fig. 24. 153-inch whole log chipper and 1500-hp. driving motor in West Coast woodmill

at this roll conveyor loading point. The feeding of cants to the rolls is accomplished through a combination of lift skids and cant stop hooks in a manner evident from the photo.

Figure 22 shows the head of the log transfer from the hydraulic barker and the roll conveyor to the chipper. The chipper operator at the left controls both the log stop and loader at the head of this transfer and the cant feeding mechanism seen in Fig. 21. A 30-inch log is shown entering the chipper spout.

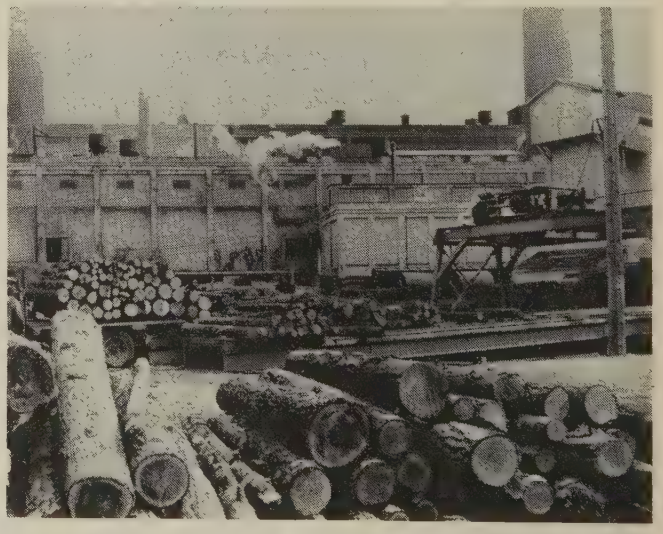

Fig. 25. Two-line winch equipment developed for unloading 8-foot wood from flat-bed trucks

The device shown in Fig. 23 controls the feeding of logs to the 153-inch chipper, its purpose being to slow the descent of the log in the spout and reduce the impact upon the disk. The need for such control is evident when one recalls that the maximum log may be 33 inches in diameter and 32 feet in length. In operation the log is brought forward upon the spiked rolls of the feeder apron until it strikes the back bumper; the apron is then raised by the hydraulic cylinder and the log

descends into the chipper spout under the control of a manually operated brake.

Figure 24 shows a 153-inch whole log chipper and its 1500-hp. driving motor. This six-knife chipper, revolving at 277 r.p.m., will reduce a 33-inch diameter log, 32 feet long, to chips in less than 30 seconds.

Fig. 26. Another view of truck unloading equipment. Inclined lug chain transfer conveying wood to operating floor of mill may be seen at extreme right

With rising log costs most of the western mills have made some provision for supplementing the wood supply by the purchase of small diameter 8-foot wood from farmer wood lots. Figure 25 shows the equipment developed for unloading this wood from flat-bed trucks. In this operation two cables are led from the movable winch at the right of the photograph around

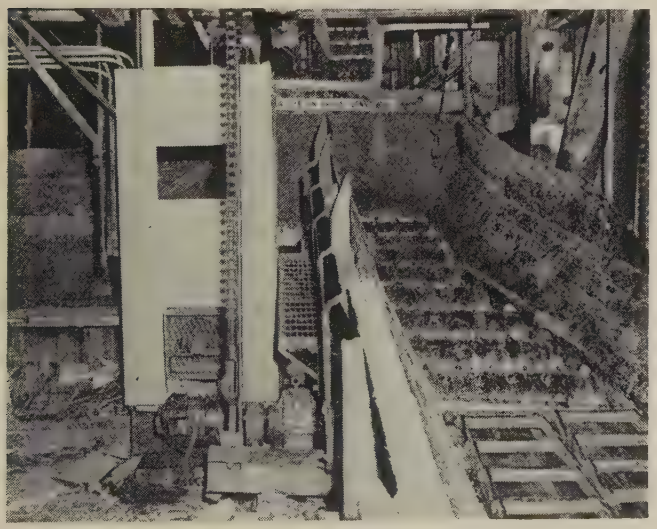

Fig. 27. Spiked roll installation developed to separate chipable material from sawmill waste

the load on either side of the truck and brought back and attached to anchors located below the steel transfers. The winch in pulling the cables rolls the entire load off the back of the truck and onto the transfer as shown in Fig. 26. This shows the general arrangement of the truck unloading equipment. The two-drum winch is mounted on a carriage and may be moved into position to serve either of the two transfers. Each of the transfers has its own drive unit and they normally operate as two independent transfers. If desired it is possible to couple the two driving units together and operate the two transfers as a single four-chain transfer capable of handling wood up to 20 feet in length. In the extreme right of the photograph will be seen the inclined lug chain transfer leading up to the operating floor of the mill.

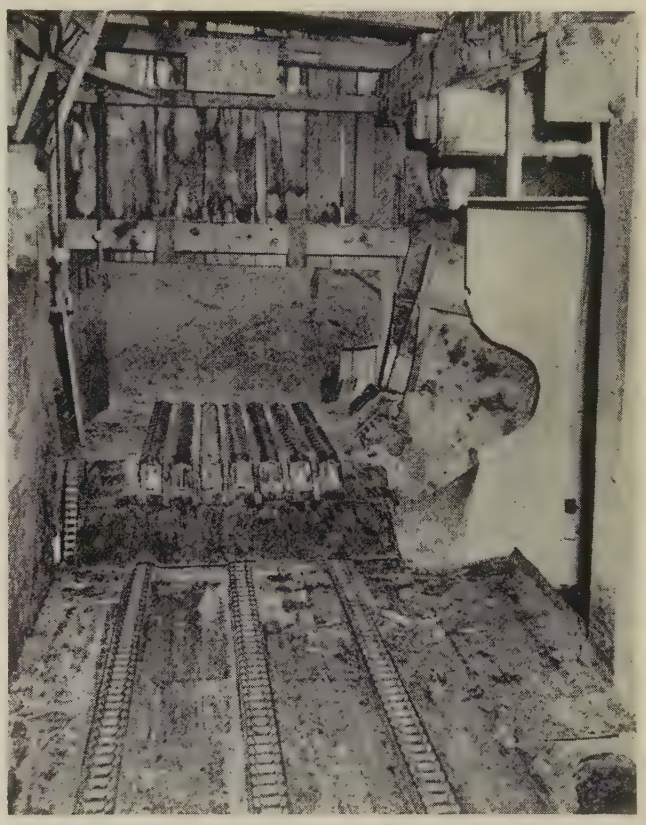

Fig. 28. Wood discharged from the spiked rolls is thrown out onto the roof top chains shown in this photograph

Many of the West Coast sawmills, engaged primarily in lumber manufacture, are now barking their logs as they enter the mill and converting all usable waste to chips. A spiked roll installation developed to separate all chippable material from the general mill waste is shown in Fig. 27. These spiked rolls, revolving at high speed, discharge the large pieces onto roof-top chains shown in Fig. 28, the sawdust and smaller pieces fall through the rolls into the refuse conveyor below. The roll case is hinged at the far end and may be raised by a motor-driven hoist to discharge all material to the refuse conveyor when desired.

Wood discharged from the spiked rolls is thrown out onto the roof-top chains shown in Fig. 28, approximately 95% of the larger pieces being straightened out to land crosswise on the chains.

In conclusion it is to be noted that the pieces of equipment described are actual installations, each of which is operating every day in one or more mills on the West Coast.

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Suspension Burning of Bark Refuse

R. ELLWANGER

Previously classified as a waste product resulting from the operation of paper mills, bark refuse now assumes a prominent place as a low cost substitute fuel for steam and power generation. A short history of wood burning from piles to the development of a boiler, furnace, and auxiliaries designed primarily for suspension burning utilizing flash drying and extreme furnace turbulence is discussed. The problem of efficiently burning this material is resolved in this presentation to two main topics—first, fuel handling and preparation and second, fuel burning and the combustion system including an analysis of fly ash reinjection. Figures are presented on predicted and actual performance together with efficiencies and carbon loss.

ORIGINALLY, the most common type of wood and bark refuse furnaces were of the flat grate, Dutch oven style provided with a multiplicity of feed openings. The fuel supply charged to the grate was uncontrolled in its feed and distribution over the grate surface, and air was usually admitted through doors in the furnace front and allowed to drift haphazardly around the smoldering pile. Later, forced draft was used under the fire and still later, overfire air jets were introduced to increase combustion rates. Further development brought forth longitudinal dividing walls for the Dutch oven with drop nose arch construction; an attempt was made to determine a definite pattern for overfire air jets; and considerable thought was given to the proper location for feed spouts. This was further developed in the inclined grate type.

However, limitations of this type of furnace and grate soon became apparent and designers turned to low-set spreaders, complete water-cooled furnaces, and traveling grates in their search for more efficient tools with which to burn bark.

About this time, our company became actively interested in the bark-burning problem and a thorough investigation was made throughout the industry for the most promising design.

SELECTION OF EQUIPMENT

Much pioneer development had been done at a large southern chemical plant on a high set spreader applied to a traveling grate stoker with an air and semiwater cooled setting employing overfire air jets and using spent wood chips as fuel. Analysis of this operation seemed to indicate that considerable promise existed for an application of suspension burning of bark. Using this as a basis of design and with the test results and visual observance of the afore-mentioned installation as a guide, a suspension burning furnace was developed for our conditions.

It was decided to design the boiler around a 550 air-dry ton pulp production level, but absolute figures were not available on the actual quantities of wood refuse. In addition, the moisture content was a widely fluctuating variable, swinging between 30 and 50%. At the time, we were undecided on whether the wood preparation department would operate 16 or 24 hours per day which, of course, would affect the maximum rate of steam generation if outside storage were not involved. With all factors considered and the economics involved, we finally elected to design for a maximum continuous rating of 90,000 pounds per hour but with fan capacity and other factors provided to develop 150,000 pounds per hour in the event that the unit proved to have the high capacity characteristics we had reason to expect.

With the possibility of 16-hour wood yard operation and no bark storage, we deemed it expedient to provide for burning either oil or coal for off-period operation.

Uppermost in our minds was a determination to so design this unit and its auxiliaries that it would serve not only as a wood-burning boiler but as a power generating unit of exceedingly high availability in the power setup.

EQUIPMENT

The unit was designed around a representative sample of bark of the following analysis:

Proximate analysis, %	*Moisture-free*
Moisture	...
Volatile matter	75.42
Fixed carbon	23.04
Ash	1.54
B.t.u. per lb.	9260
Ultimate analysis, %	
Moisture	...
Carbon	51.69
Hydrogen	5.97
Oxygen	40.65
Nitrogen	0.10
Sulphur	0.05
Ash	1.54

We realized from the beginning that worth-while gains in burning bark in suspension were obtainable with proper hogging to achieve reasonable small size reduction, which would, in turn, accomplish three major objectives:

1. Assist in moisture evaporation and rapid combustion, which would support the highest degree of suspension burning.
2. Facilitate feeding from a live bottom surge bin without bridging or interruption of fuel flow to the furnace and thus assure continuity of operation.
3. Simplify transportation at conveyor transfer points, which would provide continuity of fuel flow and the almost complete elimination of handling labor.

An exploration of available hogging machines caused us to decide on a high-speed, rotating cylinder knife hog because of the apparent greater size reduction afforded the fuel. We were well aware that this finer size reduction would have to be done at somewhat increased power costs, but we felt justified inasmuch as we were convinced that fine particle size would permit the ulti-

R. ELLWANGER, Chief Engineer, The Chesapeake Corp. of Va., West Point, Va.

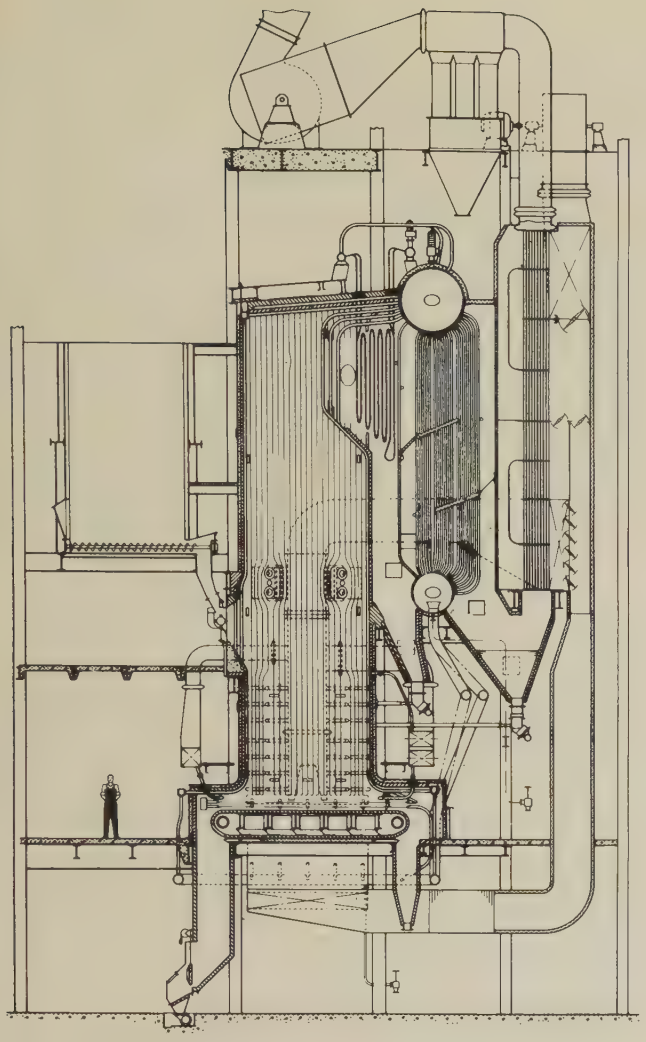

Fig. 1. Sectional side elevation of the bark boiler installation at The Chesapeake Corp. of Virginia, West Point, Va.

mate in controllable suspension burning. Accordingly, two 13½-ton per hour machines were purchased, either of which normally provides sufficient capacity. During the Winter months, one machine handles our requirements very nicely, but during the late Spring and Summer months when the bark is sappy and tough, both machines are operated to achieve more uniformity of product.

To provide continuity of operation an electromagnet has been placed ahead of the hoggers and sequential electrical interlocking provided on the five conveyors and all related equipment. The control center for all conveyors and preparation equipment was located beside the combustion control panel on the main operating floor of the boiler house so as to be under absolute supervision of the operator.

Since the definite possibility existed of burning coal, the 16 helicoid screws of the live bottom surge bin were provided with four variable speed d.c. motors, providing a speed range of 50 to 1, to insure sufficient latitude for both fuels.

Reference to Fig. 1 will aid in intelligently following a brief description of the bark boiler. From the sectional side elevation it will be noted that the furnace is completely water cooled with two short arches at the front and rear of the boiler with the ash discharge at the front of the unit. The furnace dimensions are 11 feet 0 inches deep by 13 feet 7¼ inches wide. The four 20-inch wide high-set spreader distributor units are mounted 17 feet 0 inch above the traveling grate stoker and 17 feet 9 inches below the opening to the superheater section.

The average furnace height is 44 feet 0 inch from the grate surface to the roof tubes. Below the spreader units are 28 tangential overfire air jets, 14 of which are located in each sidewall. The rear wall of the furnace contains 21 overfire air jets under the rear arch and 21 overfire air jets in the upper rear wall 13 feet 0 inch above the grate surface.

The eight type "T" oil burners are located four in each sidewall with one air jet located between each group of two burners. The horizontal center line of these jets is located 3 feet 6 inches above the center line of the spreader distributors to furnish overfire combustion air in this vicinity. The total furnace volume is 6150 cubic

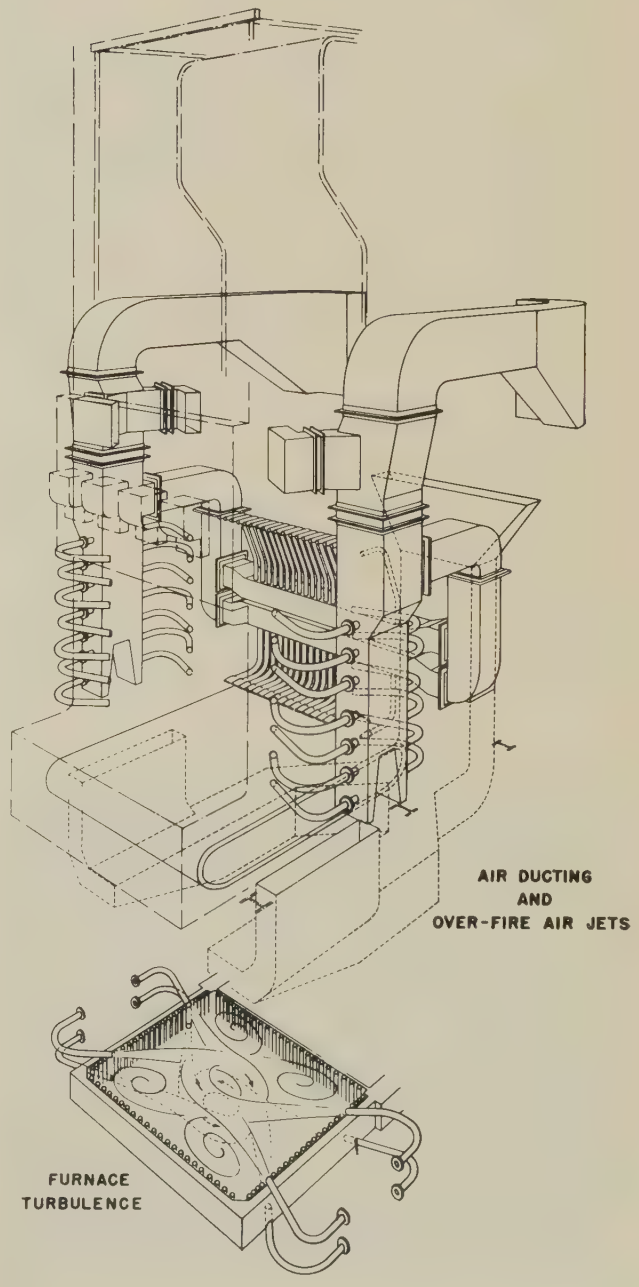

Fig. 2. Isometric view of suspension burning furnace illustrating arrangement of overfire air jets and furnace turbulence

feet with a total heating surface of boiler and furnace of 14,205 square feet. Design pressure is 600 p.s.i., but the unit is being operated at 430 p.s.i. at the superheater outlet.

The superheater is a standard crossflow pendant type and the boiler bank is strictly of crossflow design employing monolithic baffles. The tubular air heater contains a combined heating surface of 12,770 square feet. The dust collector is of the multitube type having 21 tubes of 7 by 3 deep.

The induced draft fan is driven by a 300-hp., 2300-volt induction motor with a magnetic coupling between driver and fan for variable speed control. The forced draft fan is a 125-hp., 2300-volt induction motor directly connected to the fan employing vane control for admission of forced draft air.

In designing for suspension burning we were convinced of the advantages of fine size preparation, as previously discussed, to obtain the most rapid moisture evaporation and combustion. Combined with the flash drying and suspension burning principle, incorporated in this design, is extreme furnace turbulence. This is clearly evident in the observation of the furnace through the roof doors. It contributes fundamentally to the high combustion rates and complete combustion obtained with this type of firing. This turbulence and distribution of the overfire air which produced it are illustrated in the isometric diagram in Fig. 2 showing the plan view of the furnace. The combustion air at approximately 500 to 550°F. and from 3 to 6 inch static pressure is introduced through seven rows of tangential nozzles in the sidewalls, in which the direction of rotation is reversed in alternate rows. The effect of the component forces of these jets, shown in the figure, is to completely fill the furnace with a rapidly swirling gas mass. That portion of the bark not burned in suspension (probably about 15%) is distributed relatively uniformly over the entire grate surface.

Depending on the number of rows of jets selected to rotate in any given direction the net result is to produce flow within the furnace in one direction or another. Because the furnace is, as shown, completely filled with this turbulent gas mass, it makes little difference in which direction the net resulting swirl rotates. The

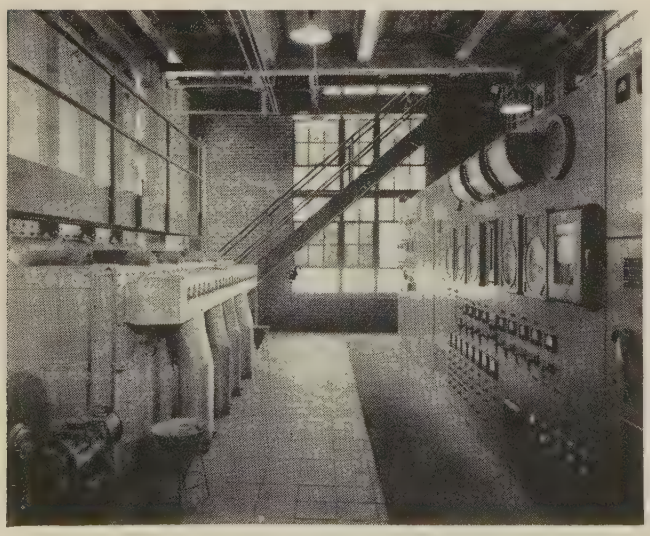

Fig. 3. View showing instrument and control panels, front casing of bark boiler, and main firing aisle

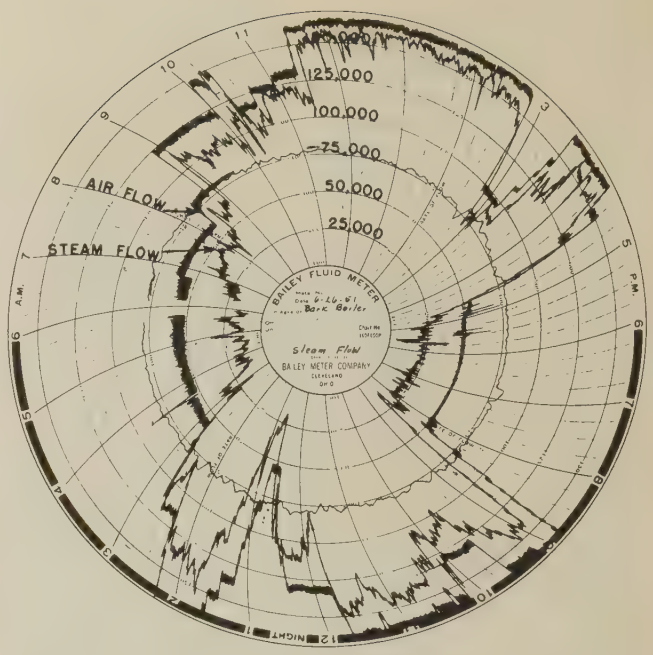

Fig. 4. Typical steam flow chart burning bark refuse

rear wall jets as well as those between the oil burners are used as required for air supply and turbulence for smoke control and provide wide latitude in operating procedure thus maintaining excellent combustion characteristics, even at high loads.

The advantages of suspension burning are immediately obvious while its outstanding characteristic is the ultrafast responsiveness to load changes because of the absence of a heavy fuel bed.

It was our understanding that because of the very nature of spreader firing that carry-over occurs with the low-set spreader method of burning bark. It was, therefore, assumed that because of the extreme turbulence and effective use of furnace volume resulting from the use of high static jets that this carry-over would be no greater using the high set spreader. It was thus realized by all interested parties that an integral part of this design should include reinjection of fly ash.

Therefore, efficiently collecting the carry-over and redepositing it in the furnace for high carbon utilization and subsequent sand collection appeared desirable. Two steam-matic exhausters of 6-inch size were located one in each sidewall 3 feet 6 inches above the grate surface for reinjection from the precipitator hoppers. Four steam-matic exhausters of 4-inch size were incorporated for reinjection from the four pass hoppers. These enter the rear wall of the furnace. All six venturis discharge in a low turbulence area and, accordingly, the unburned carbon is effectively deposited on the grate where it burns to completion, and the entrained sand remains quietly on the grate and is carried forward to the ash pit. Under high load conditions, as much as a 2 to 3-inch bed of sand is continuously discharged to the pits indicating that once the sand is redeposited, it stays on the grate due to the low velocity of forced draft air under the stoker since the major portion of the air is introduced above the grate by the overfire jets. Tests at 130,000 pounds per hour load indicate a dust loading as low as 0.306 grain per cubic foot to the stack. These results indicate that the collector is operating at a high level of efficiency (between 88.0 and 94.3%).

Figure 3 indicates a photographic view of the boiler firing aisle, and combustion and electrical control panels. The equipment consists essentially of three-element feedwater controls utilizing steam flow, water flow, and drum level recorders as the actuating mediums. An eight-point recording thermocouple, an oxygen recorder, and a smoke density recorder are incorporated together with 21 draft gages A furnace pressure controller is employed to maintain constant negative pressure in the furnace while air flow is varied manually by a control rheostat on the magnetic coupling of the I.D. fan. Flow of fuel to the furnace is under stepless control of the 16 helicoid screws operating in groups of four, each group being driven by a variable speed d.c. motor employing electronic rectification. These units provide a 50:1 speed range which can be further widened to about 70:1 if desired. This wide latitude of speed permits fine adjustment of combustion rates.

OPERATING RESULTS

This unit was placed on the line Jan. 15, 1951, and was operated for a break-in run of 23 days at which time the unit was taken off the line for 6 days to replace roller bearings which had failed on the magnetic coupling and to correct improper brickwork installation which had prevented the proper downward expansion of the water-cooled sidewalls and bottom ring header. The unit was off the line again for 36 hours on Feb. 19 and 20 for a further correction of the expansion trouble. The boiler then remained on the line until April 15 when installation of the reinjection system was carried out. Placed on the line April 19, the unit has been in constant service since this date. As of Aug. 1, it had operated a total of 4412 hours out of a possible 4688 from Jan. 15 through July 31. Of the above three outages, all were scheduled except the forced outage necessitated by the failure of the magnetic coupling bearings. Except for these three instances the unit availability has been better than 99%.

Performance

The following heat balance tabulation illustrates typical performance at a rating of 130,000 pounds of steam per hour.

Heat loss due to dry gas	5.9%
Heat loss due to moisture and hydrogen in fuel	13.7%
Heat loss due to carbon monoxide	0.2%
Heat loss due to combustible in refuse	1.0%
Heat loss due to radiation	0.5%
Actual boiler efficiency by difference	78.7%
Guaranteed boiler efficiency at 90,000 pounds steam per hour	75.0%

It is interesting to note that the unit is often operated at a capacity of 160,000 pounds per hour for 3 to 4 hours. At this capacity, the furnace heat release is 38,000 B.t.u. per cubic foot per hour and a grate heat release rate of 1,260,000 B.t.u. per square foot per hour.

Figure 4 is a reproduction of a typical steam flow chart which indicates all extremes of operation from a low of 10,000 pounds per hour to a high of 160,000 pounds per hour with a $3^1/_2$-hour run at an average corrected steam flow of 154,000 pounds per hour.

Several performance tests have indicated that the total carbon loss to the stack and ash pit is of the magnitude of 1% which results are obtainable principally because of the design of the furnace and jets, as well as the efficiency of the reinjection system.

CONCLUSIONS

In the design of any piece of equipment and its auxiliaries, the most important objective is that it shall be continuously available and able to produce. Reliable continuity of production at any predetermined rate is of the utmost importance. Little satisfaction can be gained from an otherwise highly efficient installation if frequent outages are experienced. Now that the shake down runs are over and the minor design changes completed, our service records indicate that an availability closely approaching 100% may be expected.

One of the most attractive features of this entire installation is its operating flexibility in the handling of rapid load swings encountered at times in the manufacturing process. Since approximately 85% of the combustion is done in suspension a simple increase or decrease of fuel supply will effect an immediate pickup or drop-off of load from minimum to maximum steaming rate or vice versa. This is very evident from a closer inspection of Fig. 4.

Performance test results give an efficiency of 78.77% at 123,000 pounds per hour steaming rate. It is interesting to note that after $6^1/_2$ months of continuous operation, there is apparently no sand erosion or cutting evident on the boiler heating surfaces. The higher capacity levels from 90,000 to 160,000 pounds per hour have been reached with ease and with operating performance in line with our expectations.

Before a basis of comparison can be made, it must be stated that our old Dutch oven, three-cell type furnace, and boiler were not of sufficient capacity to burn all of the available refuse. On this basis, our records indicate a production of 2195 pounds of steam per ton of air dry pulp on the old unit while the new unit produces 3010 pounds of steam per ton of air-dry pulp.

The savings in fuel cost in this installation represent the major portion of financial return on invested capital. The reduction in direct operating labor resulting from the incorporation of the bark boiler into our main power plant building as well as the elimination of maintenance on refractory settings and water-cooled grates have likewise effected an appreciable saving. Even with the increased cost of additional kilowatt input for auxiliaries, the maintenance cost of the hoggers, and the additional steam used by the fly ash reinjection system, the bark boiler installation is yielding an attractive return on our investment.

Additional attractive yearly savings could be effected by providing outside storage capacity and thereby permitting base loading of the unit to reduce the extreme high and low operating levels.

The ability of the boiler installation, however, to support easily a much higher level of pulp production is, in itself, a factor to be weighed heavily when a financial analysis of the installation is involved.

The development of this unit and its auxiliaries has advanced bark refuse to the role of a low cost substitute fuel capable of supplying steam to the power plant header through the medium of a modern dependable steam generator.

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Mill Engineer's Selection of a Paper Machine Drive. Part II

A. N. BALL

The various types of drives for paper machines are divided into four main divisions, as follows: (1) sectional electric drives, (2) single motor electric drives, (3) direct-connected turbine drives, and (4) hydraulic variable speed drives. These are discussed on the basis of the results of a questionnaire which was distributed to the mills.

MANY have read Roland Packard's paper entitled "Mill Engineer's Selection of a Paper Machine Drive—Part I," given at the Fourth Engineering Conference in 1949. He also gave an interim report in October, 1950, at the Fifth Engineering Conference held in Cincinnati, Ohio, in which he advised of the steps he had taken and intended to take to obtain a cross section of the experience of the industry with various types of paper machine drives. The information requested was for installed costs, maintenance costs, reliability, and efficiency as experienced by the individual mill. This experience was to be the basis of Part II of the report.

Unfortunately, Mr. Packard was later called to Washington to fill an important appointment for an indeterminate length of time. After giving the matter due consideration he decided he would be so fully occupied with his new responsibilities that he would be unable to give the preparation of this report the attention it deserved. In order that the work would continue, Mr. Packard paid the author a personal visit and requested that he take over and complete it.

A large number of questionnaires were sent out, and the replies to them were very encouraging. The questions that were asked were of such a nature that unless a machine drive had been installed or completely renovated within the last 12 years, the information requested would not be available. However, we were fortunate enough to receive replies to about 25% of the questionnaires, which, under the circumstances, was very gratifying. Utilizing the information obtained as a basis, a general cross section of the thinking of the industry has been prepared.

The direct-connected water wheels and reciprocating steam engines can be practically ignored in the present day and age as far as prospective new installations are concerned. It is, therefore, our intention to examine the various drives wherein electric motors and steam turbines supply the main motive power, differences being largely in the methods of application. It is this method of application which is of such vital concern to the papermaker since the nature of the product he is manufacturing dictates the range of speed and the magnitude of the draws. The drive will be required to produce and accurately maintain these draws as well as provide a ready and accurate means of adjusting them.

Various methods are resorted to in transmitting power to the machines, each suited within its own particular range. Comparisons should be considered in the light of the requirements necessitated by the grades of paper being manufactured.

Before going into the various types of paper machine drives, a review of the requirements of such a drive is timely.

PAPER MACHINE DRIVES

A drive will be required to fulfill the following functions reliably, consistently, and, from the operator's point of view, simply:

1. Maintain an over-all machine speed within the limitations of the machine, as selected by the operator.
2. Provide means of accelerating and decelerating each section of the machine, and when necessary, a prolonged slow crawl for any section, as well as inching.
3. Rapid and accurate draw adjustment for individual sections. Also, adjustment of the wet end section should automatically adjust all forward units, whereas adjustment of the dry end section should automatically adjust all preceding units.
4. Momentary speed changes in any section to take up slack.
5. Facilities for reversing the calender stack are very desirable when running many grades of paper—where plugging is somewhat prevalent.

For clarification and simplicity of approach the various types of drives have been divided into four main divisions, as follows: (1) sectional electric drives, (2) single motor electric drives, (3) direct-connected turbine drives, (4) hydraulic variable speed drives.

Sectional Electric Drives

There are two general classes of sectional electric drives which can be divided into (1) a prime mover driving a single motor generator set which, in turn, drives the individual sections through direct-connected d.c. motors; (2) a prime mover driving separately excited motor generators for each driven section of the machine transmitting the power through d.c. motors to the various sections.

Briefly, all types of sectional electric drives receive power from either an a.c. line through a synchronous motor or from a steam line through a steam turbine. Either of these prime sources of power would drive a d.c. generator, or a group of d.c. generators serving the d.c. motors on each section of the machine, which motors obtain a secondary control for synchronizing purposes from some form of regulator furnished with each section motor. Depending on the system used, each section regulator would control its respective

A. N. BALL, Chief Engineer, The E. B. Eddy Co., Hull, Que.

motor to hold precisely the selected speed relationship as referred to a master reference speed through automatic adjustment of field strength on either the respective motor, or the field of the respective section generator, the latter being used only if a multiple generator system is used.

The prime mover for either of these systems can be a synchronous motor, a steam turbine, or, better still, the synchronous motor and turbine coupled. The synchronous motor generator set and steam turbine is the most flexible setup. The synchronous alternator acts as a motor or a generator. The steam turbine can be adjusted to take the full load and the alternator float along. The alternator, preferably connected to a large hydro plant, governs the speed of the whole set. Having an alternative prime mover is valuable in case of a breakdown of either one.

With such an arrangement care must be taken that the back pressure on the turbine is always greater than the highest pressure that would ever be required in the driers. The turbine will then act as a primary, automatically regulated, back pressure reducing valve for the machine steam requirements.

Without the synchronous motor coupled to the turbine the weight of the paper which can be made on the machine without having excess steam from the turbine is somewhat limited. This excess steam must be handled with care or variations in machine speed may readily occur.

The single motor generator set, with the individual d.c. motors on each section, with the various sectional controls on draws and group acceleration, have been in successful operation for a good many years, more particularly on high-speed, wide machines. Throughout the years many improvements have been made so that at the present time this type of drive answers all the essential drive requirements. However, some slight variations in speeds still exist, but with the latest design these variations have been reduced to a low level. The author believes he is correct in saying that all the more recent installations of high-speed news machines in Canada are of this type of drive, although one completely renovated newsprint machine was equipped with the multiple generator drive in 1945.

In the replies to the questionnaire we had no report on the multiple generator type of drive. Having no direct knowledge of their operation it would be unwise in this report to attempt a description when several excellent papers have been delivered in recent years giving in some detail the equipment and controls recommended by the manufacturers.

Single Motor Electric

The single motor electric drive has the same prime mover as the sectional electric, driving the d.c. generator, which supplies the current to a single d.c. motor mechanically connected to the individual sections of the machine through cone pulleys and belts or variable speed V belt drives and back stands.

Direct-Connected Steam Turbine

The steam turbine, direct connected to the line shaft through a speed reducer has the same method of mechanical transfer of the power to the individual sections of the machine as the single motor electric drive. The turbine speed is controlled automatically, but it is necessary to have an operator on duty for one or more turbines at all times. This speed regulation is of paramount importance. The design of turbine governors has been carried to a high degree of reliability with very small increments of speed change resulting from load changes.

Hydraulic Variable Speed Drives

In the hydraulic variable speed transmission the prime mover consists of a synchronous motor driving the different "units," so-called, which are connected to the driven sections of the machine. A "unit" consists of a "pump" with adjustments to vary the pump capacity, and a hydraulic "motor" which receives the pumped oil. The motor acts in reverse to the pump and transfers the pressure and velocity of the fluid to mechanical power, the volume governing the speed and the pressure corresponding to the power transfer. The "pump" and "motor" of the unit are connected with extra heavy piping and the "motor" direct connected to a speed reducer. No clutch is necessary because the system controls the speed from zero to maximum. Infinite speed variations are obtainable.

General—For All Drives

All indrive shafts are direct connected to the units being driven, with the exception of the drier sections. The conventional type of drier drive for speeds up to 1300 f.p.m. with 5-foot diameter driers is the open-type meshed spur gear. For speeds over 1300 f.p.m., good practice dictates the use of the totally enclosed, pressure-lubricated, helical gear train.

DRIVE EFFICIENCY

All fourdrinier machine drives fall into the schematic arrangements shown in either Figs. 1 or 2, if you substitute some other type of prime mover instead of the motor generator set and d.c. motor. However, to avoid repetition it is proposed to leave the substitutions out of the discussion.

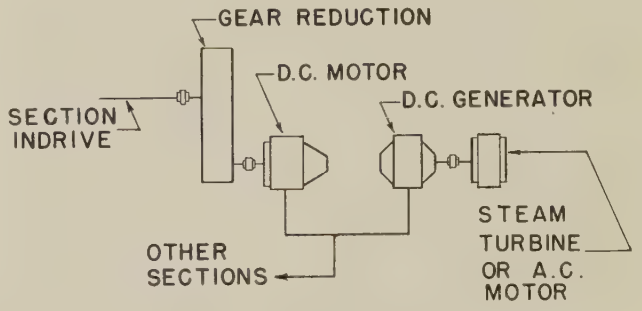

Fig. 1. Sectional electric drive

In Fig. 1, the prime mover may operate one d.c. generator which in turn supplies the direct current to several individual drive units, or it may operate individual d.c. generators, each with separate excitation, which supply the power for the individual drive units.

Figure 3 indicates a single motor electric drive. The same mechanical arrangement is used for any substitute for the prime mover indicated.

Since the two systems are virtually the same with the exception of the extra line shaft, belting, and right-angled gearing, a comparison of the efficiencies is indicated in Fig. 3 for the various design speeds, with the inefficiencies of the additional belting and gears added for the complete drive on the single motor arrangement. No attempt is made to chart the efficiency of a steam turbine drive since there are so many

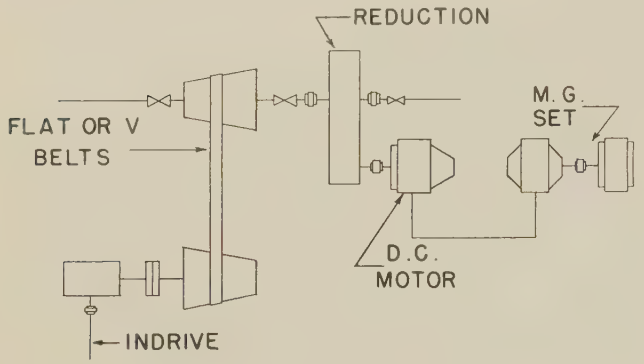

Fig. 2. Mechanical drive

variables, such as initial steam pressure, exhaust pressure, and efficiency of the utilization of the steam for drying purposes.

In considering the efficiencies of any electrical type of drive it must be borne in mind that the power required for starting the machine necessitates the motors to be oversize insofar as running loads are concerned. This applies more particularly to the sectional type of drive, and is emphasized in the TAPPI constants showing the wide difference between normal running load and recommended drive capacity.

Nearly all manufacturers of sectional electric drives have therefore made the individual sectional motors on the large side. Further, in the interests of standardization, they have not attempted to tailor-make each motor to the section but have applied duplication of motor sizes where at all possible. While this has the effect of making the drives a few points less efficient on an actual power input, other factors, such as ability to start or to inch the load, better speed regulation, and rapid control response, far outweigh the small loss in efficiency.

The figure indicates a speed range considered within the limits of the single motor electric drive and cone pulleys. Any greater speed range would cause undue slippage and further loss of efficiency which is not computable. The V-belt type of drive would permit a somewhat wider speed range due to grip of the V belts at low speed.

For purpose of arriving at an efficiency curve a hypothetical machine has been considered which would require an installation of approximately 500 hp. for a single generator type of drive. On the basis of standard motor generator and d.c. motor efficiencies, we arrived at a table giving the power input for normal running load and recommended drive capacity. Using these computations as a basis, efficiency was computed as compared to various percentages of full speed on normal running load. Since the power requirements of a paper machine within the limits of from 500 to 1000 f.p.m. are considered to be a constant torque application, we have assumed that the motor and generator losses would be practically constant over this speed range.

Mechanical Drives

From the replies received to the questionnaire, it appears that the application of the motive power mechanically connected to the various sections of the machine is still the most commonly used drive, but this type is usually applied to existing machines which have been modernized and increased in speed up to a maximum of around 1000 f.p.m. New and high-speed installations generally favor the sectional electric type of drive. Many installations of the single motor electric drive seem to have been favorably considered since they lend themselves to gradual modernization at a rate that reduces capital outlay and enables the operating personnel to maintain or improve quality in keeping with the gradual speed-up.

Certain points in the mechanical drive renovation might be mentioned here to advantage.

Cone Pulleys. Cones should never be over $^3/_4$ inch per foot taper. A single arm pulley should never be over 24-inch face. Over that, a double arm pulley should be used. Rim speeds should not exceed 5000 f.p.m. The cone pulleys on the drier section can well be reduced to $^3/_8$ inch per foot taper. The push-button type of reversible, motor-operated, belt shifter is the best modern practice.

V Belt Short Center Drives. The advantage of this type of drive over the cone pulleys appears to be mainly as follows: (1) higher line shaft speed possible with less power loss on the resultant smaller shaft, (2) about 4% higher efficiency within the speed variations practical on cone pulleys, and (3) less space required for installation

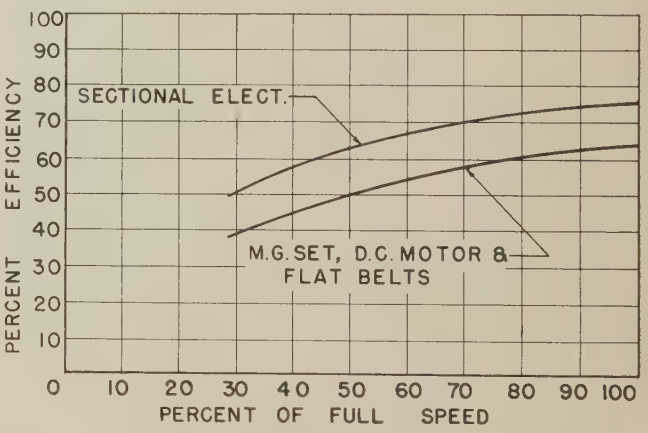

Fig. 3. Drive efficiencies

purposes. Disadvantages: (1) considerable difficulty in changing the V belts in some designs and (2) great care must be taken to insure that the proper alloy is used in the varispeed sheaves.

Clutches. When inching or crawling driers for any length of time, clutches tend to heat up rapidly causing heavy maintenance and machine troubles. To overcome this many mills have resorted to separate auxiliary

motors specifically for the crawling of the driers.

The two most prominent types of modern paper machine clutches are the disk type and the drum type. By the nature of things, when "inching" or "crawling" high-speed machines, a great deal of heat must be produced. The disk type has mass metal to absorb the heat and the drum type has forced ventilation to remove the heat. It would, therefore, appear that to avoid excessive maintenance on clutches for the higher speed machines, helper motors are advisable. However, either type of clutch should be reasonably satisfactory for inching. The drum type has good possibilities of getting the cooling air in such quantities that there is every possibility it may prove very successful even for a "crawling" service for machines up to 800 f.p.m.

Back Stands. Both types of belt drives require right-angled speed reducers. The spiral bevel and the hypoid are the most generally accepted types. Both are highly efficient, but the hypoid type is gaining rapidly in popularity due to its having continuous shafts on both gears, permitting rigid support of the shaft and perfect alignment.

INSTALLATION COSTS

A very good response was received to the questionnaire on the installation cost and the total installed cost on sectional electric drives—which are indicated in Figs. 4 and 5. These show quite clearly that the higher the horsepower requirement, i.e., the larger the machine, the lower the installed cost per horsepower.

No installation costs were available on single motor electric drives. This is probably due to the fact that machine drives altered to this type are usually done piecemeal, and no over-all record kept as to the cost.

MAINTENANCE COSTS

A good response was received in reply to the questionnaire on maintenance.

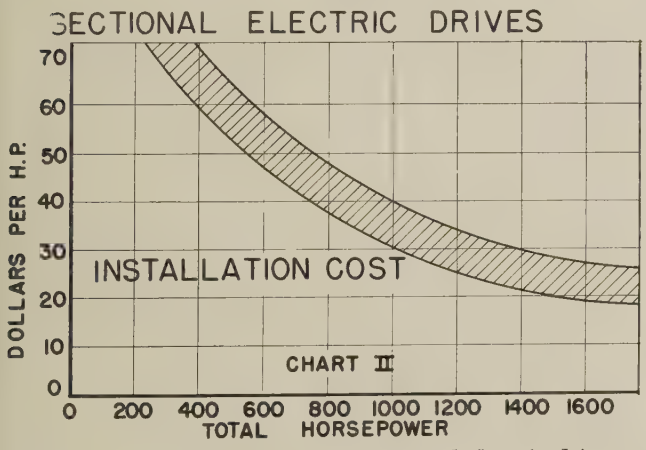

Fig. 4. Installation costs of sectional electric drives

Sectional electric drives indicated a slightly lower cost per horsepower-year than single motor electric drives. For sectional electric drives the average cost was \$1.98 per horsepower year, with the low \$0.81 and the high \$3.12. No particular trend was indicated as might be expected from age, speed, and power. Therefore, it is assumed the differences must be debited against other causes, such as the type of drive and degree of preventive maintenance.

For single motor electric drive, with cone pulleys and hypoid gears the range is surprisingly close to the sectional electric. The average for this type of drive

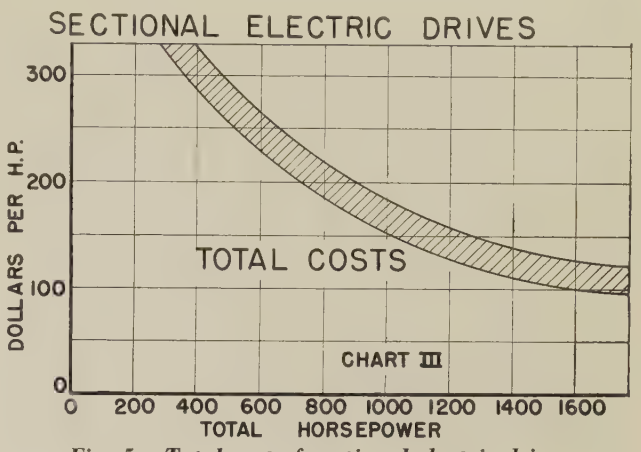

Fig. 5. Total cost of sectional electric drives

was \$2.25 per horsepower-year with the lowest \$0.73 and the highest \$4.70.

PRODUCTION EFFICIENCY

Drive production efficiency was based on annual production hours less machine down time for drive trouble—divided by the annual production hours.

The replies to this portion of the questionnaire indicate that production efficiency of sectional electric drives is extremely high, the average being 99.5%, with the highest 99.93 and the lowest 98.7%.

For single motor electric drives or similar drives the production efficiency averages 94.5%, the high was 99.9 and the low 86.1%.

BOARD MACHINE DRIVES

Board machine drives follow the same general trend as the fourdrinier machine drives with one very important exception, that is, the mechanical helper drive on the wet end of the machine is being supplanted very rapidly with the electrically operated helper drive, with the speed controlled from the first press. This type of drive enables any or or all of the cylinder molds, a water removal drum (whether suction drum, suction roll, or what have you), and any or all of the primary presses to be driven. The resultant increase in felt life and decrease in crushing the sheet are pronounced. In case of power interruption and to prevent tearing of the felt, the helper drive must be electrically hooked up to the first press clutch so that no matter whether the first press or the helper drive power fails, both automatically shut down.

CONCLUSION

In studying the various points of the general survey, the following points stand out clearly.

(1). For machine speeds of over 1000 f.p.m., the rapidity of adjustment and accuracy of speed regulation

indicate a definite advantage in favor of the sectional electrical drive.

(2). A well-maintained single motor electric drive is an extremely satisfactory drive and answers all the requirements at speeds of less than 1000 f.p.m. with the exception that an adjustment of the wet end section will not automatically adjust all forward units, nor will adjustment of the dry end section automatically adjust all *preceding* units.

(3). Crawling can be accomplished with both systems with helper motors. With narrow, reasonably slow machines (around 750 f.p.m.) the drum-type clutch will permit crawling of the driers for a fair length of time. For speeds in excess of 750 f.p.m. it is advisable to slow down the driers during crawling operations to save the burning of and the resultant high maintenance on clutches.

Therefore, for the renovation of existing machines, where speed is limited to 1000 f.p.m., for reasons either mechanical or sheet formation, the single motor electric drive or its equivalent have a definite place. Slipping of belts is unavoidable at best, and creates a condition at times requiring more adjusting than is desirable, but this condition is not serious at 1000 feet or less.

Any proposed drive for a paper machine must be studied with all the other machine potentialities, properly appraising the possibilities such as ultimate speed, production requirements, future life, or the period when obsolescence will justify the removal of the unit, that is, when a new drive would be considered with the new machine.

Although maintenance and first cost on a paper machine drive are of definite importance the cost of the drive itself is so small in comparison to the investment on the machine as a whole that the ability of the drive to give the required control and dependability is what is of paramount importance.

In choosing a drive, the more help obtained from operation and maintenance in this over-all appraisal the happier the resulting decision will be. There is no substitute for experience.

The author would like to take this opportunity to thank fellow TAPPI members, and his own company associates, who have so kindly cooperated and made this survey of modern practice possible.

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The Characteristics of Wood Pulps for Use in the Manufacture of Viscose

H. HAAS, E. BATTENBERG, and D. TEVES

For dissolving pulps purity is the most important requirement, therefore, the question must be asked whether, why, to what extent, and how the compounds which accompany the cellulose in the wood are to be removed. Lignin is the only component in wood which must be removed in the production of both paper and dissolving pulps. The third main constituent of wood comprises the hemicelluloses. The reasons for its removal and the reactions of the various pulping and dissolving agents are discussed. In addition to the removal of organic contaminations, the ash content must be held to a minimum since it can cause serious trouble in subsequent spinning operations.

There are significant differences in the characteristics of dissolving and paper pulps. In order to meet the requirements for these two kinds of pulps, the manner of processing the wood must be different to some extent. The task in one case is to obtain the fibers and in the other the cellulose from the wood. That is in no way the same thing, because the fibers may contain a considerable amount of the noncellulosic constituents of the wood. For dissolving pulps purity is the most important requirement. Therefore, the question must be asked whether, why, to what extent, and how the compounds which accompany the cellulose in the wood are to be removed.

H. Haas, Member TAPPI; Head, Pulp and Paper Division; E. Battenberg and D. Teves, Research Chemists, Research Laboratory, Zellstoffabrik Waldhof, Mannheim-Waldhof, Germany.

To begin with the lignin the differences are not so great as they seem. The lignin is the only component of the wood which must be attacked in every case. However, for paper pulps, it may be sufficient to remove only a portion of it or even only to soften it in order to make it mechanically less resistant, whereas it must be removed completely from dissolving pulps. Nevertheless, the differences are only gradual and there is no difficulty in removing it entirely. The so-called "residual lignin content" of dissolving pulps will be discussed later.

The third main constituent of wood, besides the cellulose and the lignin, comprises the hemicelluloses or "wood polyoses." The latter term was proposed by Staudinger (*1*) to make it clear that these compounds should be clearly distinguished from degraded cellulose. Why must they be removed? Because of their low degree of polymerization they do not contribute to the strength of the rayon produced and, because of their solubility in alkali they lessen the laundering resistance of the rayon. However, more important than these influences upon the quality of the finished rayon are the difficulties they cause during the xanthation process. The reason is not that the wood polyoses do not react or do not form soluble compounds with alkali and carbon disulphide, although isolated wood polyoses were sometimes found to behave in this way. On the contrary, there is no doubt that mannan and pentosans

(such as xylan) in their native structures react quite well and even more readily than cellulose. For example, some investigators have demonstrated that the medullary ray cells of beech pulp, which are high in

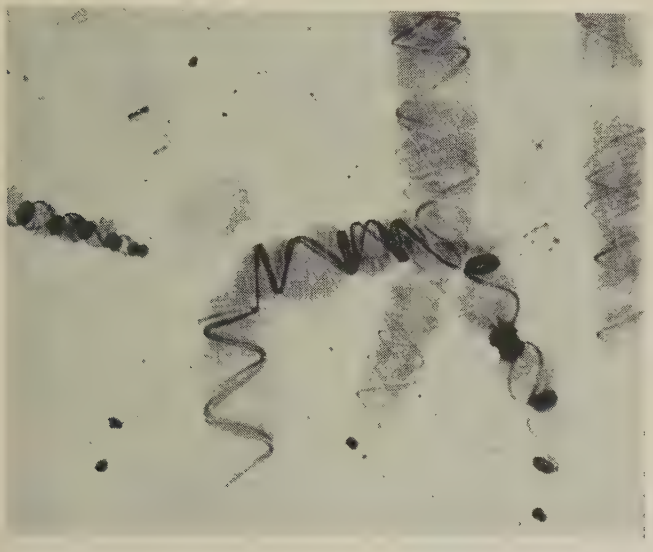


Fig. 1. Spruce pulp, xanthated. Magnification 1:115

pentosan content, react faster than the tracheid cells which have a lower pentosan content. Likewise, residues of xanthated and partly dissolved fibers of spruce pulps were found to have a lower content of mannan and pentosans than the original pulps (*2*). Further-

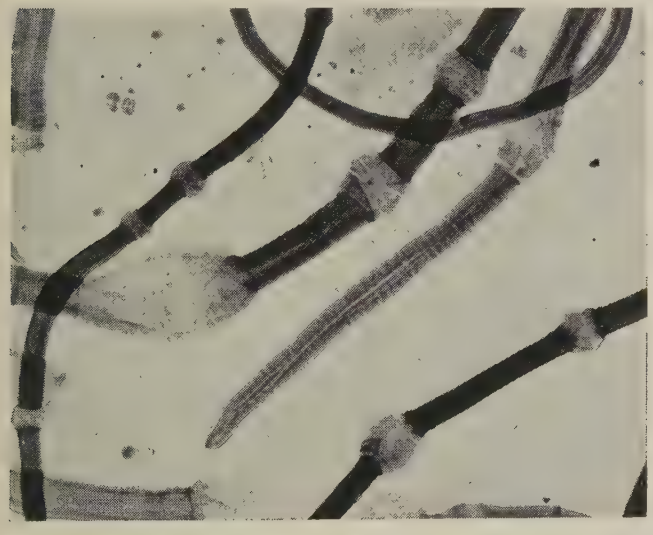


Fig. 2. Spruce holocellulose after 20 min. treatment with CS_2. Magnification 1:100

more, this behavior of the wood polyoses may be clearly recognized when observing the course of the xanthation of wood cellulose fibers under the microscope. Practically, the wood polyoses are located entirely in the outer layer of the secondary cell wall. Figure 1 shows the well-known picture of swollen cellulose fibers; it was taken from xanthated spruce pulp fibers. The outer layer of the secondary cell wall can be clearly seen on some of the fibers because it is stained darker than the middle layer, which consists of cellulose. The swelling of the cellulose layer causes the fibrils of the outer layer to be pushed together so that they form small rings, or they are drawn out into spirals. In the unswollen fiber, they are wound around the middle layer at an angle of about 90°. Other fibers in Fig. 1 are completely free of residues of the outer layer.

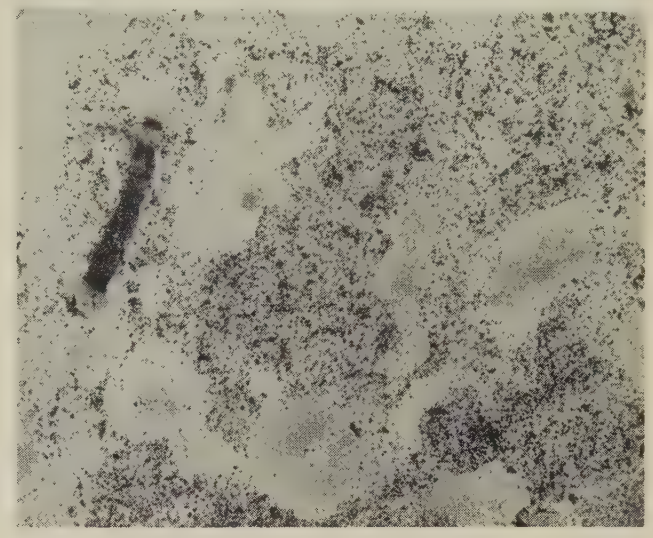


Fig. 3. Spruce holocellulose extracted with dil. cuprammonium hydroxide and xanthated; after 20 min. treatment with CS_2. Magnification 1:75

Xanthated holocellulose fibers, which still contain the whole amount of wood polyoses present in the original fiber, look different (Fig. 2). Large portions are covered with intact outer layer material and only at some places do the fibers show the ballooning effect.

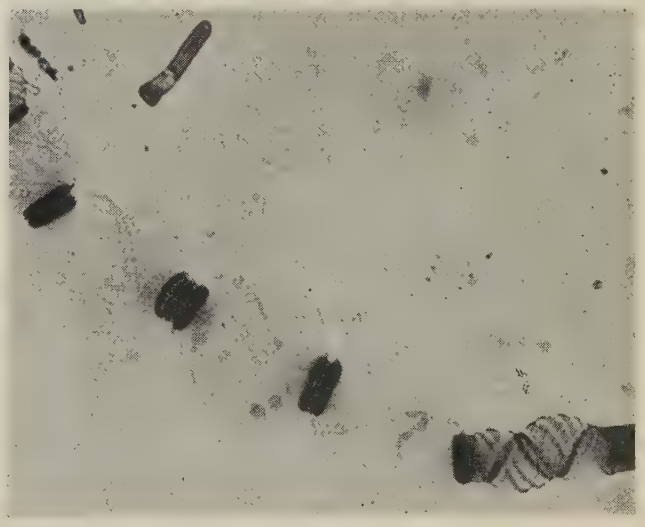


Fig. 4. Beech pulp, xanthated. Magnification 1:320

One may remove the outer layer (from the original fibers) with dilute cuprammonium hydroxide solution, which is a specific solvent for wood polyoses (*3*). In fact, holocelluloses or pulps, treated with this reagent

and then subjected to fractionation, contain no fractions with D.P.'s under 200. Simultaneously, the outer layer of the secondary cell wall disappears. Figure 3 shows fibers which, after being treated with this reagent, were xanthated in the same way as were the

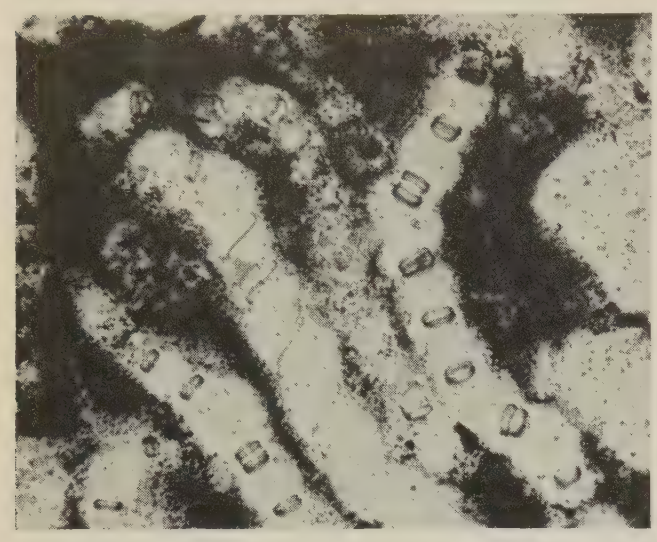


Fig. 5. Beech pulp, xanthated; after 30 min. treatment with CS_2 (TiO_2 dispersed in the preparation). Magnification 1:195

fibers of Fig. 2. It is seen that only one small piece of undissolved outer layer remained. The other fibers are nearly completely dissolved. Some fragments of the middle layer containing the cellulose are made visible by dispersing titanium dioxide in the preparation.

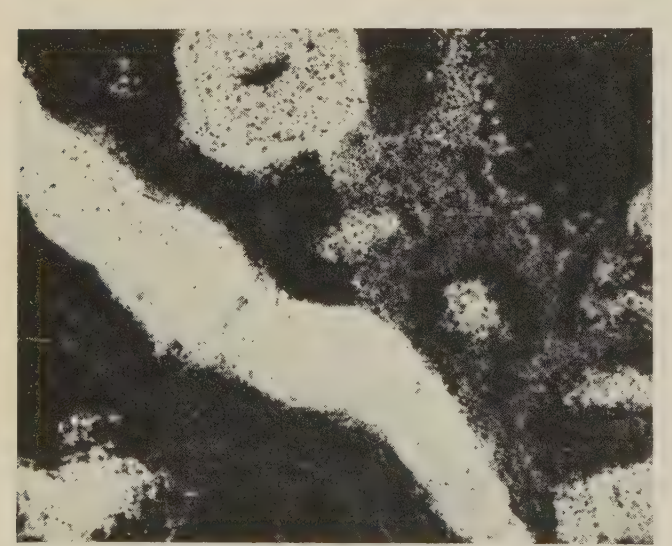


Fig. 6. Beech pulp, xanthated; after 5 hr. treatment with CS_2 (TiO_2 dispersed in the preparation). Magnification 1:250

In this way, highly swollen cellulose gels are made visible; otherwise they are transparent and invisible, even with the aid of polarized light.

Without the addition of titanium dioixde, pictures of fibers in an advanced stage of solution may lead to false conclusions. Thus, Fig. 4 seems to show that the rings of the outer layer are far from being dissolved, whereas the inner layer has disappeared almost completely. In reality, however, the course of the reaction is quite different; Fig. 5 shows a similar picture with titanium dioxide added. The dark portions, consisting of titanium dioxide, surround the transparent cellulose gels, which appear bright. In the inner portions of these gels, the transverse windings and rings of the outer layer are seen. Both inner and outer layer are not yet dissolved. In Fig. 6, which was taken some hours later, the remainders of the outer layer are scarcely visible, whereas the cellulose is not yet dissolved. Indeed, the last residues which one observes are always pieces of the middle layer (i.e., of cellulose) and never those of the outer layer containing wood polyoses. This observation is in accordance with the chemical findings mentioned above. Fibers of different wood species react in the same way except for differences in the resistance of the outer layer toward swelling and in

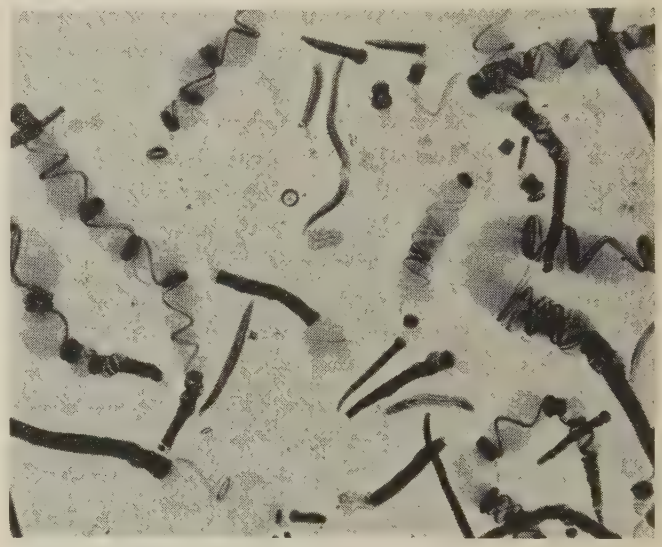


Fig. 7. Beech pulp, xanthated. Magnification 1:110

their reactivity—a difference which is particularly great in beech fibers.

Nevertheless, the influence of the wood polyoses in the outer layer upon xanthation and upon the solution of the xanthated wood fibers are very undesirable because their presence prevents the fibers from reacting uniformly. Figure 7 demonstrates the nonuniformity of reaction of beech pulp. On large tracts of the fibers, the cellulose in the inner layer is not able to react because it is covered with the unswollen and firm outer layer. The protected parts of the inner layer can react only after the outer layer is at least partly dissolved—that is, later than other uncovered parts. For reasons peculiar to the xanthation this time difference is rather critical. Esterifications of cellulose are usually carried out with a large excess of the esterification reagent—e.g., as in nitration and acetylation. Not so with xanthation. Only one fourth of the carbon disulphide which the alkali cellulose could possibly bind, is used in the commercial viscose process. Therefore, those parts of the fiber which react early consume more car-

bon disulphide than corresponds to the average which would be at their disposal in case of a uniform reaction. The parts which react later remain undissolved—not because they are unable to form soluble compounds but because they have no more carbon disulphide with which to react. This limitation of the amount of

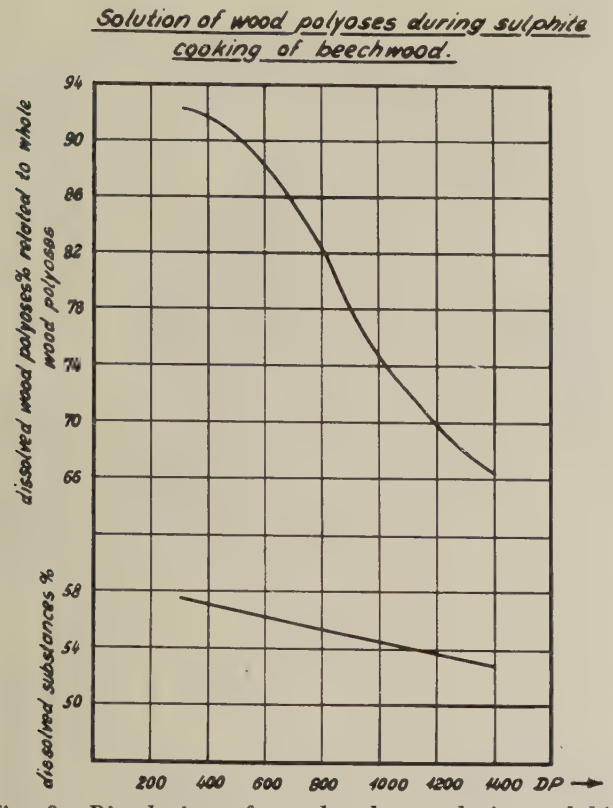


Fig. 8. Dissolution of wood polyoses during sulphite cooking of beechwood

carbon disulphide is the most important reason why the layer of wood polyoses must be removed prior to xanthation or at least must be weakened to such an extent that it can no longer form an impenetrable coat around the cellulose—i.e., the core of the fiber. Undissolved or partly dissolved pulp fibers cause trouble during the filtration of the viscose by clogging the filtering medium. This is also the reason why uniformity is the primary requirement for all viscose pulps.

No analytical test has been developed for this important characteristic. Of some help is the manufacture of a small quantity of viscose on a laboratory scale and the examination of its filtering properties, for example, by the method of Hermans and Bredée (*4*). Modern developments in pulp manufacture, such as circulation of the cooking liquor, the use of recording and controlling instruments during cooking, etc., have contributed much to a greater uniformity of the pulps. The wood itself also may cause trouble. A good method for manufacturing a pulp which does not filter well is to put lots of wood of different moisture contents in the digester. Inevitably a pulp will result which decreases the filtering properties of the viscose. Because of the different impregnation of the chips with the cooking liquor, a nonuniform pulp will result which will be partly over- and partly underxanthated. The underxanthated parts of the fibers cannot dissolve completely and form highly swollen gels with all the well-known difficulties in filtration. On the other hand, one can dissolve any pulp, even if it is not sufficiently cooked and bleached. It must only be uniform, and one must use enough carbon disulphide or one must agitate the xanthated charge mechanically (*5*) in order to expose those parts which react later to the esterification reagent. However, under commercial conditions, only pulps with their outer layer—that is, their wood polyoses—removed or weakened will react satisfactorily.

The methods of removing the wood polyoses are based on their properties which are different from those of cellulose. Most important are their solubility in alkali and the faster rate at which they are degraded by hydrolysis. The rate of scission for pentosans is about 1500 times faster than that for cellulose (*6*). The hydrolytic action of the cooking acid, especially at the end of the digestion process, results in a certain fractionation of the wood carbohydrates. That is to say, the wood polyoses become soluble earlier than the cellulose because their initial D.P. is only one tenth that of the cellulose and their rate of scission is much greater. In Fig. 8, the total amount of substances dissolved and that of the pentosans alone are plotted against the D.P.'s of the resulting pulps (comprising a number of digestions of beechwood at varying cooking time). It is seen that the curve for the removed pentosans rises very steeply with decreasing D.P.'s, whereas the curve for the total substance dissolved (the diminishing yield) rises only gently.

The greater the hydrolytic degradation, the purer is the remaining pulp. This rule holds, of course, only to a limited extent because, for many reasons, the D.P.

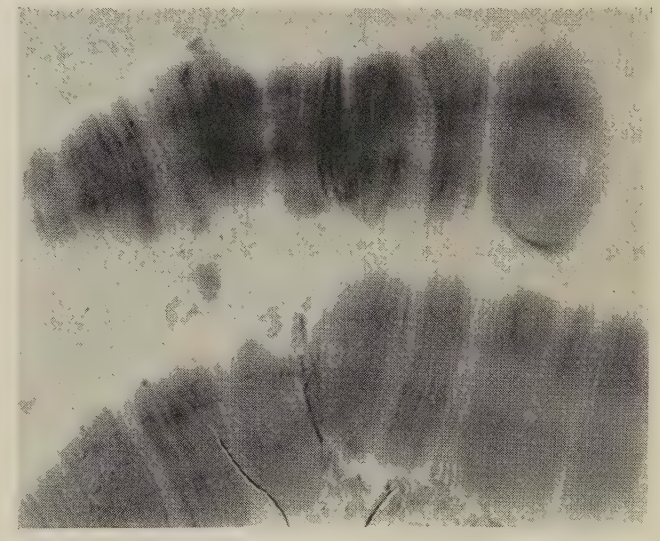


Fig. 9. Spruce pulp, xanthated. Magnification 1:120

at the end of the cooking operation must not be lowered below a certain value. If it were, the cellulose would form too many alkali-soluble degradation products, and no possibility would remain for further degradation during bleaching. On the other hand, the hydrolytic action of the cooking acid is also necessary in order that

the fibers may disintegrate in the direction transverse to the fiber axis during the subsequent esterification process.

Figure 9 shows two fibers of a xanthated spruce pulp. The transverse fissures are characteristic of all cellulose fibers which have undergone acid treatment. Dolmetsch, Franz, and Correns (7) have shown that these fissures form an angle somewhat below 90° with the axis of the fiber. The single disks cohere through the whole fiber in the form of the so-called "transverse spiral," as shown in Fig. 10. This spiral is not a morphological element of the natural cellulose fiber because it cannot be isolated through mechanical action. Only chemical (especially acid) treatments make it appear. Probably, there is amorphous cellulose situated between the single layers of the spiral, or faster-splitting bonds are located in parallel planes traversing the whole fiber. Wood polyoses do not seem to be involved in these reactions, because fibers which do not contain wood polyoses react principally in the same way as those containing them. The opening of the planes of cleavage of the transverse spiral is a necessary step in the manufacture of dissolving pulps. The degradation involved in the manufacture of viscose pulp is thus not a necessary evil—i.e., something which cannot be avoided because of the imperfection of our methods and the impossibility of handling the highly viscous solutions of undegraded cellulose. Rather, it is to be regarded as an absolute condition for making the pulp sufficiently reactive. Figure 11 shows how a beech pulp fiber disintegrates into single disks under the action of the carbon disulphide. Those "punched" disks (see Figs. 1, 6, and 11) were sometimes made responsible for filtration disturbances because they are found in the residues on the filter cloth. However, as was pointed out before, their occurrence in these residues is only the result of nonuniform reaction and lack of sufficient carbon disulphide. The necessity of an acid attack upon the fiber is practically proved by the fact that sulphate pulps are unsuitable for the manufacture of viscose.

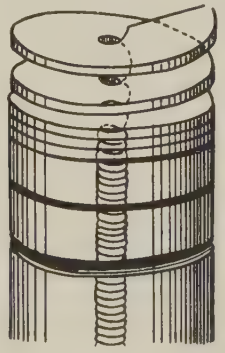


Fig. 10. Transverse fissures (disks) and transverse spiral according to Dolmetsch, Franz, and Correns

Even if they are made with a high alpha-cellulose content (by alkaline treatment during and after bleaching), the viscoses manufactured from such pulps are difficult to filter. The wood-polyoses of the outer layer of the secondary cell wall undergo a change during the sulphate cooking process which makes them more resistant (7a). Therefore, kraft pulps are more difficult to beat. Likewise, solubilization by chemical treatment is not easily accomplished. Furthermore, the fiber is stronger in the direction of the fiber axis, because the planes of cleavage of the transverse spiral are not opened. Soda pulps are known to be mechanically weaker than

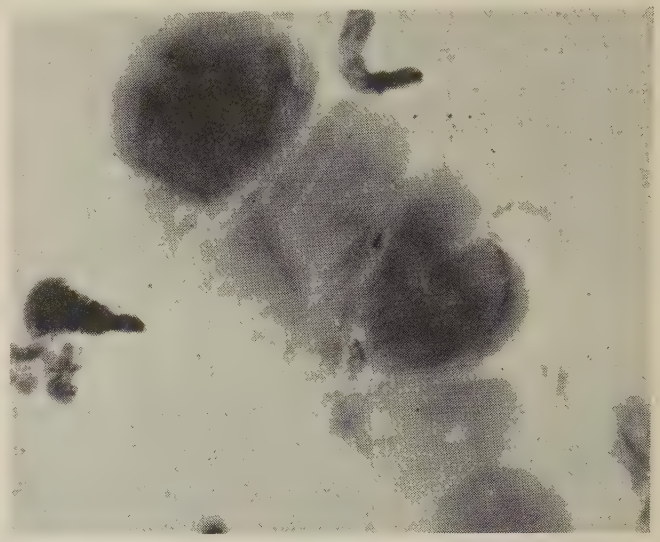


Fig. 11. Beech pulp, xanthated. Magnification 1:220

sulphate pulps and they are also easier to dissolve chemically. With the soda process the chemical attack on the fiber is more drastic than in kraft pulping. Alkaline cooked sulphate pulps can be made suitable for the manufacture of viscose only if an acid treatment precedes the alkaline cooking stage (so-called prehydrolysis). This system has made it possible to utilize the sulphate process for the manufacture of dissolving pulps. The acid treatment must precede the alkaline treatment as it does in the manufacture of bleached sulphite where the alkaline treatment is part of the bleaching process. This sequence is quite necessary because, apart from other reasons, it achieves a quick separation of the fiber into the transverse disks which is a prerequisite for uniform and complete esterification.

One of the main tasks in manufacturing dissolving pulps is to establish the right balance between the acid and the alkaline treatment. No general rule can be given because too many points must be considered and the characteristics required for the final pulps, such as average D.P. and alpha-cellulose content, vary. Each wood species behaves differently. The yield factor is also important. Maximum yield at a fixed alpha-cellullose content and a fixed D.P. is obtained only if acid and alkaline treatments are well balanced with respect to each other, a requirement which must be established by experiment. The degradation during the bleaching process should be as small as possible, because degradation by oxidation does not occur selectively as does degradation by hydrolysis. In other words, oxidation during bleaching attacks cellulose and wood polyoses in the same way.

On the other hand, the alkaline treatment during bleaching is necessary in order to remove not only the

oxidized lignin and the wood polyoses but also the oxycelluloses formed during bleaching. The latter are undesirable in dissolving pulps.

In order to study the behavior of oxycelluloses during esterification and to exclude the influence of other foreign groups present in pulps or holocelluloses, some

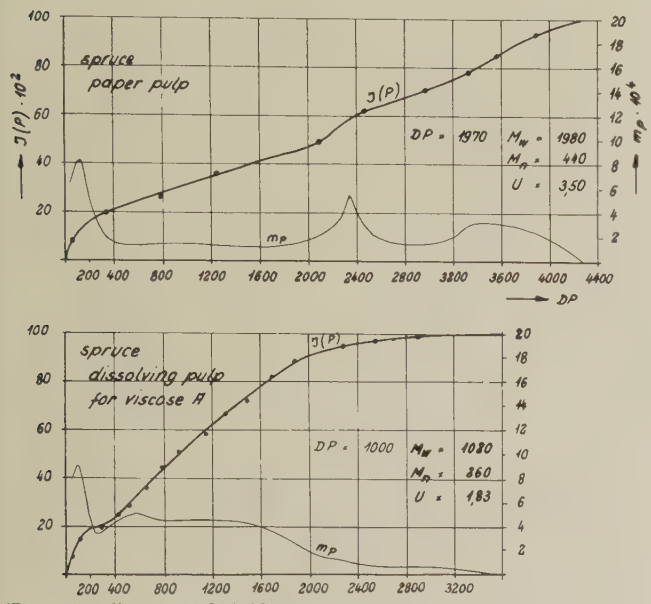


Fig. 12. Integral [J(P)] and mass [mp] distribution functions [Schulz, G. V., Z. physik. Chem., B47: 155 (1940)] of spruce pulps (rel. to 1 g. substance)

experiments were carried out with oxidized cotton linters.

Cotton linters oxidized with periodate (HIO_4) gave nitrates which were only partly soluble in acetone or like solvents if the copper number exceeded 2 for high D.P. and 4 for lower D.P. preparations. For acetates the limit for complete solubility was reached at a copper number of 5. Nitrates of cotton linters which had been oxidized with nitrogen dioxide were completely soluble only if their uronic acid content was below 5%. Since incomplete solubility usually results from incomplete esterification care was taken in all cases that the degree of substitution was high enough. Treatment of the oxidized celluloses with dilute alkali solution reduced their copper number and uronic acid content. The solubility of the nitrates and acetates of the treated oxycelluloses corresponded to that of untreated products of the same copper number.

Another remarkable feature of these cotton oxycelluloses was their instability toward heat and light. Furthermore, the solutions of these products in 72% sulphuric acid were dark as compared with the uncolored solutions of untreated linters. Table I shows some measurements of extinction of such solutions by a photometer.

The color of pulp solutions in concentrated sulphuric acid is sometimes used to determine the so-called "residual lignin content" (*8*). However, the origin of the products which we tested by the same method precludes lignin as the cause of this color. In fact, oxycelluloses can react in a similar way. The sulphuric acid test, therefore, cannot always be used to prove that lignin is present. In the case of highly bleached pulps, it is more likely that they contain some oxycellulose groups rather than lignin residues.

Undoubtedly the oxycellulose groups, if not eliminated to the necessary extent by alkaline extraction, will interfere not only with nitration and acetylation but also with xanthation and will reduce the solubility of the xanthate as well. Therefore, the alkaline treatment during the bleaching process is absolutely necessary for the removal of the oxycelluloses as well as the wood polyoses and the oxidized lignin, as mentioned earlier. It is true that the viscose process proper begins with an alkaline treatment—namely, in the steeping process. However, if all the pulp purification was confined to the steeping process, the steeping liquor would become contaminated to such an extent that difficulties would be encountered in its regeneration.

Table I. Extinction of Solutions of Oxidized Cotton Celluloses in 72% H_2SO_4

Oxidized with HIO_4		*Oxidized with NO_2*		
Copper number	*Extinction, m × 10*	*% Uronic acid*	*Copper number*	*Extinction, m × 10*
0.8	0.31	0.6	0.6	0.14
1.5	0.35	1.0	1.9	0.18
2.4	0.37	4.9	5.6	0.14
6.1	0.46	8.5	9.9	0.24
10.4	0.78	10.9	10.3	0.37
14.9	1.53			

Contaminations of wood pulps, in addition to lignin, wood polyoses, and oxycelluloses, are ash and pitch. Ash can cause serious troubles which originate in its lime and silica content. Samuelson (*9*) has explained the unfavorable influence of lime upon the filtration of the viscose by the assumption that the divalent calcium forms cross links between carboxyl groups of adjacent chains. Gypsum crystals, entering the spinning jets, may also lead to serious trouble. The manufacture of pulps with low lime content is only a matter of water

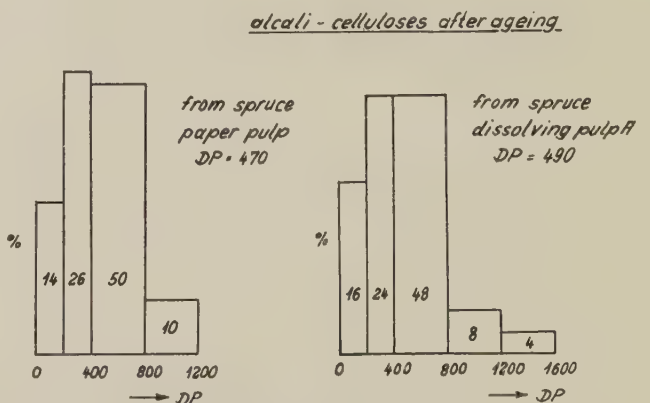


Fig. 13. Distribution diagrams of aged alkali celluloses from spruce pulps

purity. It is useless to exclude calcium as a base in the cooking and bleaching liquors if the water which carries the stock to the wire contains calcium ions. Because of its ion-exchange properties, the pulp will bind calcium ions under these circumstances. The use of soft water is the only practical way of keeping the calcium content

at the low level to which it was brought by acid treatment (*10*).

Pitch, provided it is not present in too large an amount, generally causes no trouble. On the contrary, it acts as a wetting and emulsifying agent and must even be replaced by adding synthetic wetting agents if too much has been removed. On the other hand, the pitch content of the pulp is a hint of how much of the small medullary ray cells, which are rich not only in pitch but also in other contaminations, have been removed. Unfortunately, the removal of these cells by washing requires much water.

Next to the noncellulosic constituents, viscosity is an important characteristic of dissolving pulps. Viscosity is related to the D.P. It is well known that the D.P. represents only an average value and, further, that pulps of the same average D.P. may differ very much in molecular weight distribution. Recently, much attention has been paid to this latter characteristic of wood pulps. Unfortunately, not all publications are useful. In a very thorough investigation Heuser and Jørgenson (*11*) showed what prerequisites must be fulfilled for the results to be of value. These are, mainly, (1) that fractional precipitation is used and not fractional solution; (2) that enough fractions are obtained, and (3) that the fractions are distributed equally over the whole range of D.P.'s. It is generally assumed that good quality rayon should be as uniform in molecular weight as possible and that, therefore, the rayon pulp should have a narrow molecular weight distribution curve. Undoubtedly, fractions of low molecular weight are undesirable in rayon because of their solubility in alkali, and fractions of high molecular weight because they may disturb the filtration of the viscose (*12*).

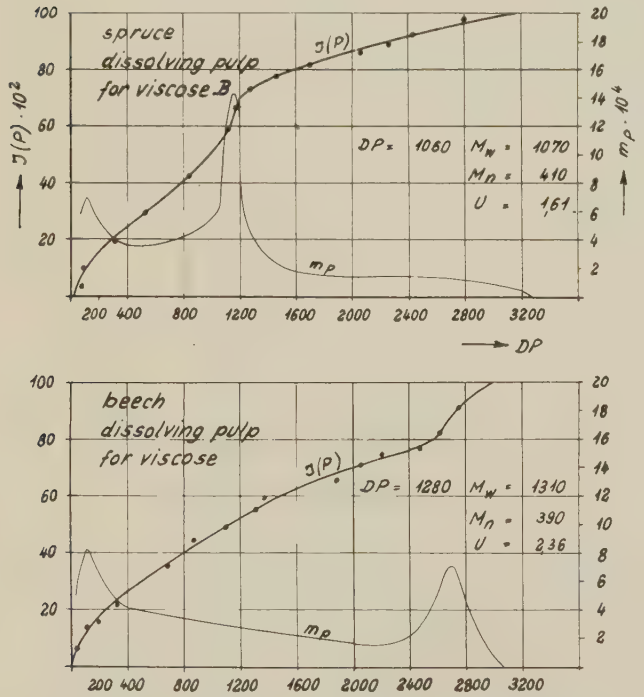


Fig. 14. Integral [J(P)] and mass [mp] distribution functions of dissolving pulps (rel. to 1 g. substance)

However, it is not yet clear whether or not and to what extent the mechanical properties of the final product depend upon its molecular weight distribution. In other words, it has not yet been proved that fibers of uniform molecular weight have better mechanical properties than others with a broader molecular weight

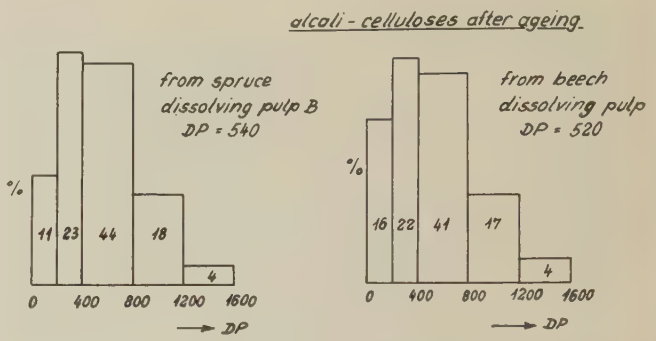


Fig. 15. Distribution diagrams for aged alkali celluloses from dissolving pulps

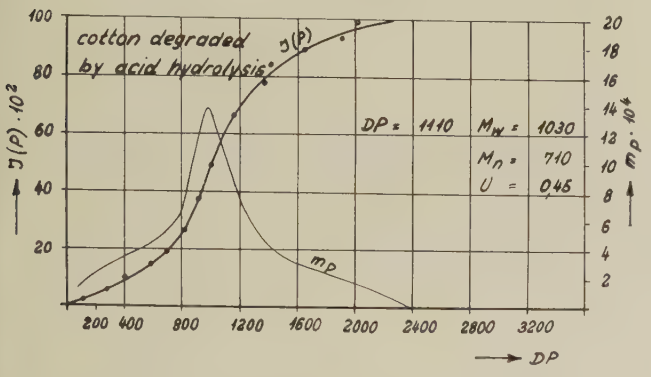
distribution. Likewise, the question whether or not the molecular weight distribution of the pulp influences the molecular weight distribution of the rayon manufactured therefrom needs clarification.

Wood cellulose undergoes a series of treatments each resulting in a certain degree of degradation. The molecular weight distribution of the pulp as it leaves the mill is important only if it influences the distribution ultimately reached. When the pulp enters the rayon plant, it suffers further degradation (that is, when the alkali cellulose is subjected to aging), whereas ripening of the viscose causes no further degradation. The various types of degradation—i.e., during cooking, bleaching, and during aging—may have different effects (*13*).

Fractionation of pulps before and after aging of the alkali cellulose has shown that this degradation procedure more or less removes differences in the molecular weight distribution. Incidentally, in all determinations of changes in molecular weight distribution, it is very important to avoid all losses of material, not only during the fractionation itself but also when the nitrates which are to be fractionated are prepared. A loss in fractions of low D.P.'s occurs if the cellulosic materials are treated with alkali prior to nitration, if the nitrates are extracted with methanol in order to "stabilize" them, or if they are dissolved and reprecipitated in order to purify them. Only in carefully prepared holocelluloses are the fractions of low D.P. free of cellulose. In pulps, such fractions contain degraded cellulose in addition to wood polyoses. If a treatment with liquids which dissolve more or less of the fractions of low D.P. cannot be avoided, the dissolved compounds must be recovered and their weight taken into consideration when drawing the distribution curves.

Figure 12 shows the integral and the differential distribution curves of two spruce pulps. The D.P.'s of the fractions were determined by viscosity measurements, using Staudinger's rule and a K_m constant of 8.4×10^{-4}. Osmotic measurements were also performed on some fractions. The osmotic molecular weights proved to be

the same as the viscosimetrically determined values up to a D.P. of about 1000. In the area above this value, the former were higher than the latter. The differences reached about 30% at a D.P. of 2000 which is the highest measurable osmotically. Thus, for all pulps which have a larger amount of fractions having a D.P. over 2000,



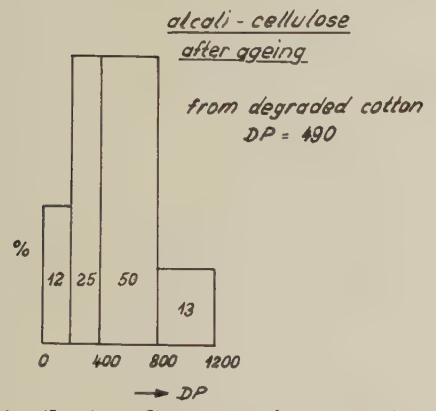


Fig. 16. Distribution diagrams of cotton degraded in different ways

the shape of the curves changes if the osmotic D.P.'s are used. Viscose pulps usually contain only small amounts of such fractions which have D.P.'s higher than 2000.

The distribution curves in Fig. 12 were also used for determining the weight and number average D.P.'s (M_w and M_n). The D.P. measured on the unfractionated nitrate agrees with the weight average D.P. as determined by the distribution curve if no losses occurred during fractionation. This comparison is possible only if the K_m constant which was used for the individual fractions is used also for the unfractionated nitrate. The agreement between these two values was satisfactory in all fractionations shown in Figs. 12–16.

The values of M_w and M_n were also used for the calculation of Schulz's nonuniformity factor, U (*14*). The upper graphs in Fig. 12 refer to a bleached spruce paper pulp which was manufactured under very mild conditions. The differential weight distribution curve shows the characteristic wood polyose maximum at a D.P. of below 200 and two further (cellulose) maxima at D.P.'s of about 2300 and 3400. The highest fraction had a D.P. of about 3900. These values are very much like those published by Heuser and Jørgenson. (*11*).

The distribution curves of the dissolving pulp (lower figure) have quite different shapes. The weight average D.P. is only about half that of the paper pulp. Ninety per cent of its fractions have D.P.'s under 2000 as compared with about 50% for the paper pulp and the 90% are distributed relatively uniformly in this area, with the exception of the wood polyose maximum. There exists no maximum between D.P.'s of 400 and 2000.

Both pulps were degraded to a D.P. of 470 to 490 by alkaline aging, using a temperature of 30 to 35°C. and varying the time. The results are shown in Fig. 13. A method of presentation which facilitates the comparison was used—i.e., for certain intervals of D.P.'s, the quantities of material are shown in percentage of the total. It is seen that the molecular weight distributions of these degraded pulps are now practically identical. The great differences which existed between them before the degradation have disappeared.

Figure 14 shows two other viscose pulps, one from sprucewood and the other from beechwood. In contrast to the dissolving pulp in Fig. 12, these two pulps have a pronounced maximum in the areas of high molecular weights. However, their location is different, being at a D.P. of 1150 for the spruce and a D.P. of 2700 for the beech pulp. The average D.P. of the beech pulp is considerably higher than that of the spruce pulp. However, these two different pulps likewise lose their differences if subjected to alkaline aging, as shown in Fig. 15. The D.P.'s of the two aged pulps are somewhat higher than those of the first two aged pulps—i.e., the pulps in Fig. 15 contain a few more fractions with D.P.'s higher than 800. On the other hand, no differences exist between them with the exception of a higher amount of fractions with D.P.'s under 200 in the beech pulp.

Finally, the same aging procedure was performed with a cotton cellulose which had been degraded by acid hydrolysis to a D.P. of 1100—i.e., a value which is normal for viscose pulps (Fig. 16, upper portion). The shape of the distribution curve of the acid-hydrolyzed cotton cellulose is significantly different from that of the commercial dissolving pulps. A pronounced maximum located near its average D.P. value of 1110 and a rather low U-value are its characteristics. After further degradation—i.e., by alkaline aging to an average D.P. of 490, corresponding to that of the pulps in Fig. 13—the distribution has become similar to that of the pulps shown in Fig. 13 (Fig. 16, lower portion). It is proved by these experiments that a degradation to a D.P. of about 500, as brought about by the oxidation of alkali cellulose, removes all differences in molecular weight distribution from pulps having D.P.'s of 1000 to 2000. It would seem, therefore, that the molecular weight distribution is not an important characteristic of viscose pulps which have to undergo alkaline aging.

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Correlation Between Mahlgrad and Tensile Strength Development of Pulp During Beating

HEINZ CORTE

As pointed out by Campbell freeness (or Mahlgrad) is closely connected to the specific surface of the pulp. This result has been obtained by application of the Kozeny equation to the flow of water of the pulp suspension through the screen plate of the freeness (or Mahlgrad) tester. Robertson and Mason have shown that there exists a correlation between the development of the specific surface and Mahlgrad development during beating as well as between the rise of specific volume and strength properties. These correlations can be made plausible by simple mathematical treatment. Each of these relations contains only one characteristic parameter, and an empirical relationship between them enables calculation of Mahlgrad and tensile development during beating if Mahlgrad and tensile values are known for the unbeaten pulp and an arbitrary beating time. Data are given on an investigation of a sulphite pulp.

The correlation between Mahlgrad* development of a pulp and the development of the strength properties of the paper produced therefrom is generally known but only in a more or less empirical and qualitative manner even though both beating process and resultant strength properties have been a matter of extensive theoretical and experimental study for a long time. A complete theory of beating and of paper strength should contain the relation between them, but even a quantitative, though semiempirical, correlation derived from simple considerations, and verified by experiment, would facilitate evaluation of further experimental data and support efforts to understand the effect of beating conditions on paper quality. It would make it possible to calculate paper strength by measuring the quality of the pulp.

No attempt will be made here to consider the whole field of pulp quality-paper quality relation, both of them being complicated by numerous involved problems open to question. To obtain a first approximation, possibly sufficient for practical purposes, and to point out the principle of our procedure this discussion will be simplified and limited to only one characteristic pulp quality, viz. Mahlgrad, as measured in the Schopper-Riegler apparatus (German standard), and tensile strength characterizing the fiber bonding in the paper sheet.

The choice of the Mahlgrad as a measure of judging the beating progress is only a matter of convenience, but as will be seen it is possible to combine quantitively the curves of Mahlgrad and tensile development by a relatively simple mathematical formalism. This paper deals with the first approximation which was found to be in fairly good agreement with experimental results obtained with spruce sulphite pulp beaten in a Valley laboratory beater.

EMPIRICAL AND THEORETICAL BASIS

The empirical basis is given by the following well-known facts:

1. The Mahlgrad curve normally shows a sigmoid shape. The inflectional point is found near 40 to 50°S.R. The maximum value lies between 90 and 100°S.R.

2. The rise of tensile strength is steepest at the beginning of beating. The maximum value is nearly reached at the time of inflectional point Mahlgrad.

3. Changes of beating conditions, such as pulp consistency, beating load, etc., affect the two curves in similar manner, the relation between them being roughly maintained.

The theoretical basis is given by various investigations of surface development, swelling, and fiber bonding published in American literature. Three of them may be mentioned briefly:

1. As pointed out by Campbell (*1*) the freeness (or Mahlgrad) test is a measure of the specific surface and the compressibility of the pulp. This result was obtained by application of the Kozeny equation to the water-flow across the pulp layer in the freeness tester. Our investigations (unpublished) have confirmed this finding and indicate some possibility that the performance of freeness test may be changed so that the result may be separated into the single factors suggested.

2. Using a modified Kozeny equation, Robertson and Mason (*2*) have developed a permeability method for the determination of both the specific surface and

Heinz Corte, Research Associate, Zellstofffabrik Waldhof, Research Division, Mannheim-Waldhof, Germany.

* The Mahlgrad test is performed in nearly the same manner as the freeness test, using a 0.2% pulp consistency. Mahlgrad in degrees Schopper-Riegler (°S.R.) is the tenth part of the difference between initial volume (1000 ml.) and the side-flow volume (in ml.), thus being M = 100 − F/10 (M = Mahlgrad, F = freeness), if freeness is measured with 0.2% consistency pulp, cf. Merkblatt 107 of the Verein der Zellstoff- und Papier-Chemiker u. -Ingenieure (German standard).

the specific volume of cellulose fibers. They found a correlation between the specific surface and freeness (Mahlgrad) and between the specific volume and burst strength. Our experiments, using the method of Robertson and Mason, have confirmed these results. In all cases investigated a bleached spruce sulphite pulp, beaten in a Valley laboratory beater, was found to show a surface development paralleling the Mahlgrad curve. Also, the specific volume was found to show the steep initial rise characteristic for tensile strength. These findings are shown in Figs. 1 and 2.

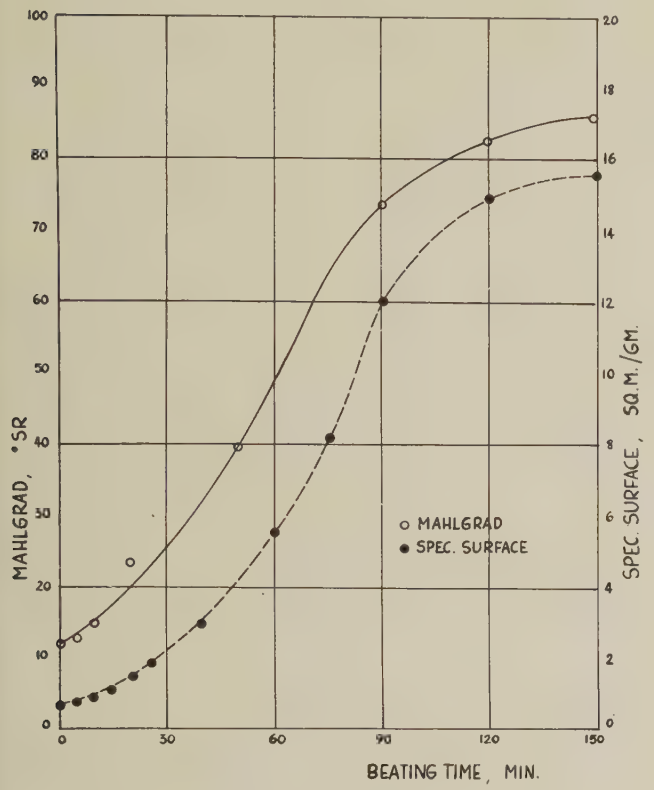

Fig. 1

3. Kane (*3*) has given a theory on the development of tensile strength during the beating of pulp. The author succeeded in describing the tensile development by a formula containing two characteristic parameters: one representing hydration rate and another representing fibrillation rate, i.e., rate of enlargement of the outer fiber surface. The initial increase of tensile strength is more affected by the hydrating rate, whereas the final tensile value is mainly affected by the fibrillation rate, maximum tensile being high if the fibrillation rate is small compared with the hydration rate.

These arguments and empirical findings may be stated, in simplified manner, as follows: the Mahlgrad development is a measure of mainly the surface enlargement of pulp, whereas the initial increase of specific volume may serve as a measure of the tensile development. It may be emphasized that this result gives little support to those beating theories which hold that fibrillation is responsible for the development of strength properties. If we assume that surface enlargement is mainly due to fibrillation, we have the fact that, at a time of fastest surface increase, the tensile strength nears its maximum value, whereas the initial slope of tensile falls into a period of slow fibrillation. Mahlgrad and tensile strength seem to represent two pulp qualities rather different from each other. Without considering here all the discussions about swelling, hydration, fibrillation, formation of surface suspension, etc., we can roughly say that, in the simplest case, Mahlgrad development represents the fibrillation and tensile strength development represents the swelling of pulp during beating. From this aspect there is a possibility to compare the two characteristic curves by plausible representation of experimental data.

MAHLGRAD DEVELOPMENT

Fibrillation may be analytically described as a reduction of the average fiber radius r, of all fibers and fibrils. As both unbeaten and widely fibrillated fibers are acted upon by the knives of the beater, fibrillation rate will gradually diminish. Assuming that r does not reach values below a minimum value r_m, given mainly by beater data, we can write

$$\frac{dr}{dt} = -k_\mu(r - r_m) \qquad (1)$$

k_μ, the fibrillation-rate constant, may depend on the degree of swelling as fibrillation rarely occurs in non-swelling liquids (*3*). This would somewhat complicate the calculation. In our investigation of bleached sulphites k_μ was found to be nearly constant. Equation (1) may be integrated between the limits $r = r_0$ for $t = 0$ and $r = r_m$ for $t = \infty$. Putting the specific surface reversely proportional to r and identifying Mahlgrad M up to a constant factor with the specific surface we obtain for the Mahlgrad development the expression

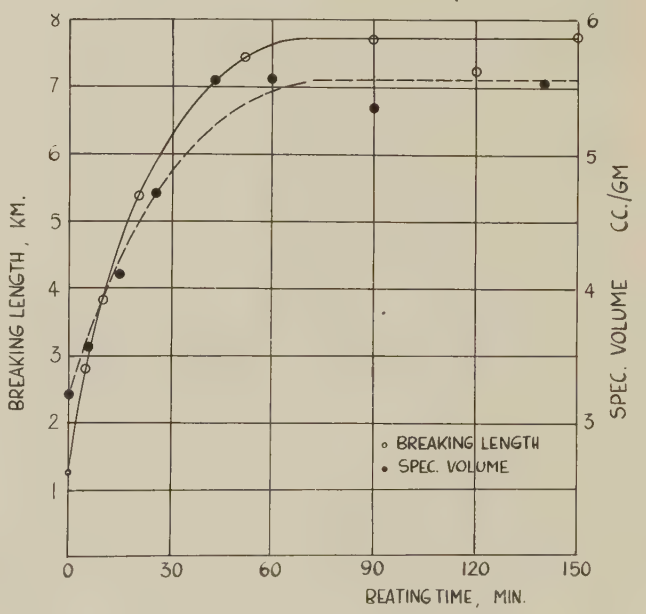

Fig. 2

$$M = \frac{M_\infty}{1 + Ae^{-k_\mu t}} \qquad (2)$$

where M_∞, the maximum Mahlgrad, corresponding to the surface at $r = r_m$, may be supposed, for practical purpose, to be 100°S.R. A is given by $(M_\infty - M_0)/M_0$ with M_0 = initial Mahlgrad.

Introducing $100/M = \mu$, we obtain by a slight tranformation of equation (2)

$$\mu = \mu_\infty + (\mu_0 - \mu_\infty)e^{-k_\mu t} \qquad (2a)$$

Thus a plot of log *nat* $(\mu_0 - \mu_\infty)/(\mu - \mu_\infty)$ versus t should give a straight line through the origin with the slope k_μ. This was found to be true for widely different beating conditions, as shown in Fig. 3, for three examples.* The values of k_μ diminish if consistency is raised or beater load is lessened, as expected. This is shown in Table I for 13 runs on the same sulphite pulp.

The graph of equation (2) is easily shown to be an S-shape curve symmetric to the inflectional point

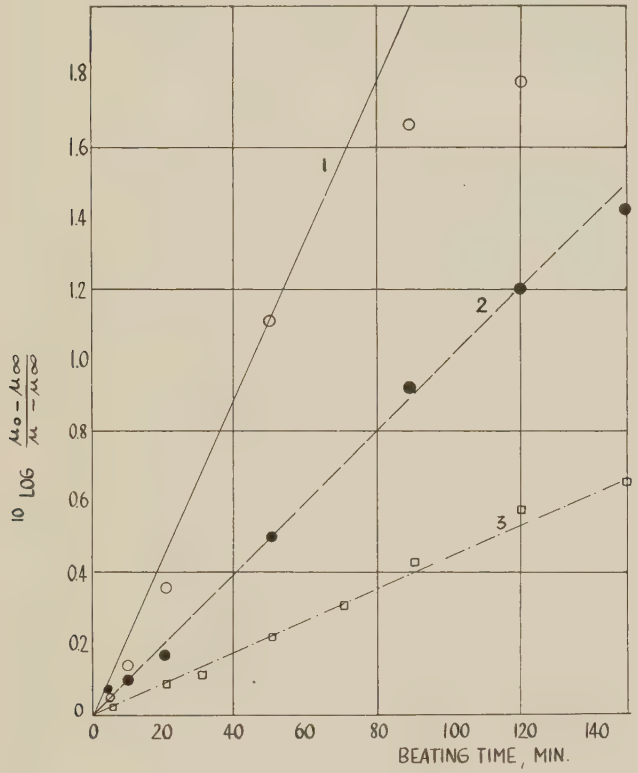

Fig. 3

(if negative t-values are included). The coordinates of the inflectional point are

$$t_w = \frac{1}{k} \ln A \qquad (3)$$

$$M_w = \frac{M_\infty}{2} \approx 50 \qquad (4)$$

TENSILE DEVELOPMENT

To obtain a similar simple representation for tensile strength data we may identify tensile development with the rise of specific volume assuming for the latter a simple exponential function to describe the approach to any swelling equilibrium. Starting with the equation.

$$\frac{dR}{dt} = k_r(R_\infty - R) \qquad (5)$$

with R denoting the tensile strength at time t and R_∞ the maximum value we obtain

$$R = R_\infty - (R_\infty - R_0)e^{-k_r t} \qquad (6)$$

where R_0 is the initial tensile strength. As in the case

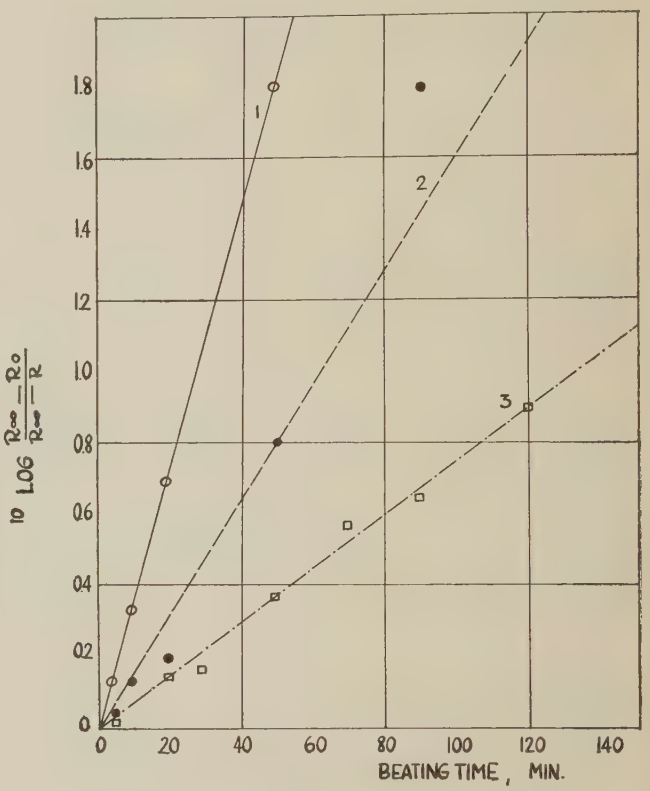

Fig. 4

of Mahlgrad development, k_r is constant in our special case, not depending on Mahlgrad or fibrillation. Thus a plot of log $(R_\infty - R_0)/(R_\infty - R)$ versus t should be again a straight line, as shown in Fig. 4 for the samples corresponding to those of Fig. 3.

TABLE I

Beater load, kg.	*Pulp consistency per weight, %*	k_μ, *min.*$^{-1}$ $\times 10^2$	*Number of sample, Figs. 3, 4, 7, 8*
14.0	1.0	5.11	1
	1.5	3.96	
	2.0	3.18	
	2.25	3.06	
	2.5	3.01	
12.2	1.0	4.61	
	2.0	2.42	
9.3	1.0	2.44	
	2.0	1.61	
7.4	1.0	2.30	2
	1.5	1.77	
	2.0	1.52	
	2.25	1.04	3

RELATION BETWEEN MAHLGRAD AND TENSILE DEVELOPMENT

Of special interest will be the proportion k_r/k_μ.

* These and the following figures concern a bleached sulphite, beaten in a Valley laboratory beater with variation of pulp consistency and beating load. The numerations of samples correspond to each other.

Equation (2) means that three data must be given for calculation of the Mahlgrad development curve: M_∞, M_0 and k_μ. k_μ can be eliminated if one pair of values for M and t is given by experiment. Doing so and assuming the value 100 for M_∞ we may calculate the Mahlgrad curve by measuring only M_0 (a material constant) and the Mahlgrad M at any beating time t (e.g., 50 minutes).

According to equation (6), for a calculation of the tensile development curve, knowledge of three data

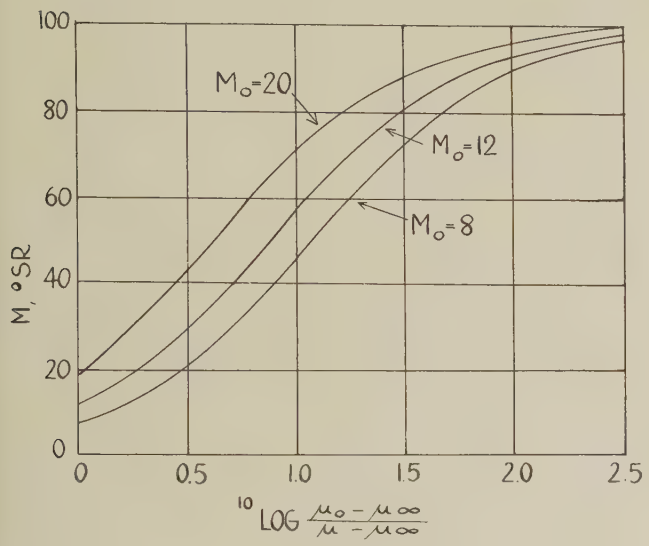

Fig. 5

is also necessary: R_0, R_∞, and k_r. Again, k_r may be eliminated by a pair of values for R and t, but the value for R_∞ cannot be anticipated by a simple assumption. Indeed, this unknown value is of special practical interest. Its elimination is possible by means of an additional assumption combining equations (2) and (6). As may be suggested by evidence we can suppose that the tensile rise $R_w - R_0$ at the time of greatest slope of Mahlgrad-curve (inflectional point time t_w) has reached a certain fraction f of the total rise;

$$\frac{R_w - R_0}{R_\infty - R_0} = f \qquad (7)$$

Now, from equation (6) follows by transformation

$$t_w = \frac{1}{k_r} \ln \frac{R_\infty - R_0}{R_\infty - R_w}$$

or, combined with (7)

$$t_w = -\frac{1}{k_r} \ln (1 - f) \qquad (8)$$

Comparing (8) with (3) we obtain

$$\frac{k_r}{k_\mu} = -\frac{\log (1 - f)}{\log A} \qquad (9)$$

In thirty Valley runs using various sulphites f was found to have values between 0.95 and 0.98, i.e., tensile strength has reached almost its maximum value when Mahlgrad rise is steepest. To calculate the tensile curves* of all beating runs investigated the relation $k_r = 1.64 \cdot k_\mu$ was used. As the initial Mahlgrad of the sulphite to which the figures of this paper are related was 12°S.R., this factor 1.64 corresponds to f-value of about 0.962.

In order to perform the calculation quite easily two series of graphs were drawn. Firstly log $(\mu_0 - \mu_\infty)/(\mu - \mu_\infty)$ was plotted versus M for the whole range of M-values from 10 to 100 putting $\mu_\infty = 1$. Another curve was drawn for each M_0-value from 8 to 20. Figure 5 shows three of these curves containing the one ($M_0 = 12$) used for Figs. 3 and 7. Second, straight lines were drawn through the origin, having slopes

$$\frac{1 - e^{-k_r t_x}}{1 - e^{-k_r \cdot 50}}$$

using several k_r-values ranging from 0.01 to 0.1 for one graph and a t_x-value (10, 20, 35, 70 . . . minutes)

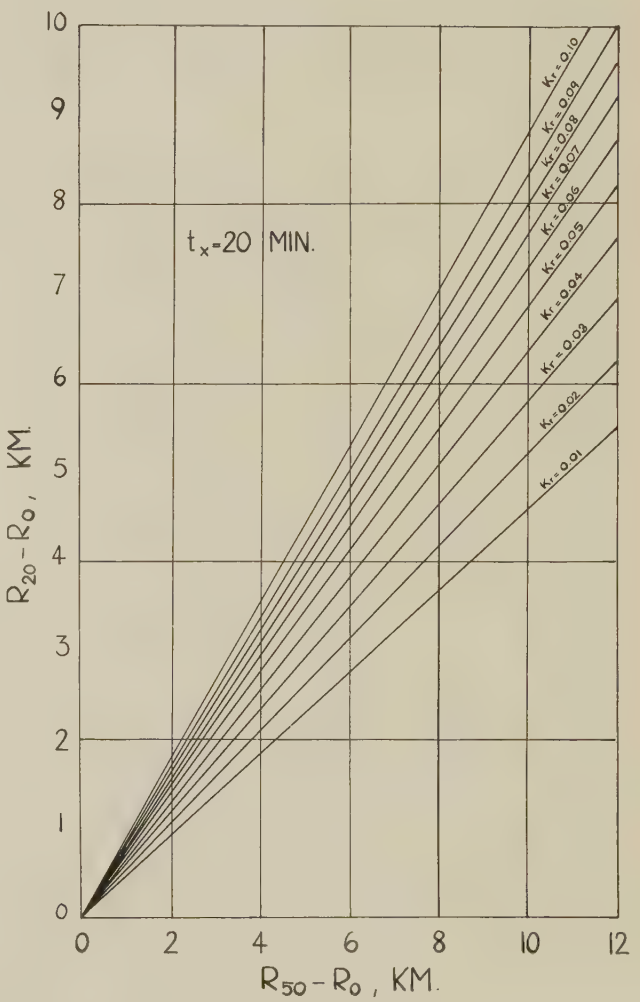

Fig. 6

for each graph. These lines, according to equation (6), represent the proportion $(R_{t=t_x} - R_0)/(R_{t=50} - R_0)$ for the various k_r-values used. Figure 6 shows such a graph for $t_x = 20$ minutes. Now, the calculation was performed in the following manner:

1. Mahlgrad and tensile strength (breaking length) were taken of the unbeaten and 50-minute beaten pulp:

* In the numerical calculations the tensile strength is given in kilometers breaking length.

in sample 1: $M_0 = 12°$S.R., $M_{50} = 64°$S.R., $R_0 = 1.30$ km., $R_{50} = 7.35$ km.

2. From the middle curve in Fig. 5 $\log (\mu_0 - \mu_\infty)/(\mu_{50} - \mu_\infty) = k_\mu'$ for $M_{50} = 64$ is found to be 1.11, whence the log-values for the other beating times (10, 20, 35, 70, etc., minutes) are easily obtained. Using these log-values, all Mahlgrad values can be taken from the same curve in Fig. 5.

3. $k_\mu = 2.303 \cdot k_\mu'/50$ was calculated. In our sample, $k_\mu = 0.0511$ (cf. Table I). Hence, $k_r = 1.64 \cdot k_\mu = 0.0838$. Using this value, and $R_{50} - R_0$ being 6.05, from Fig. 6, $R_{20} - R_0$ is found to be 4.95 or $R = 6.25$. The other R-values were obtained from graphs similar to that of Fig. 6.

Figures 7 and 8 show the curves for Mahlgrad and tensile development, respectively, calculated for the three samples mentioned here. Compared with the experimental data, a fairly good agreement is obtained. In the cases of fast beating (e.g., sample 1) agreement throughout was somewhat poorer for high beating times. This behavior was also found with other beaters and other than sulphite pulps and leads to the suggestion that the first approximation needs a fundamental correction affecting mainly the result for high beating times, especially in the case of fast beating.

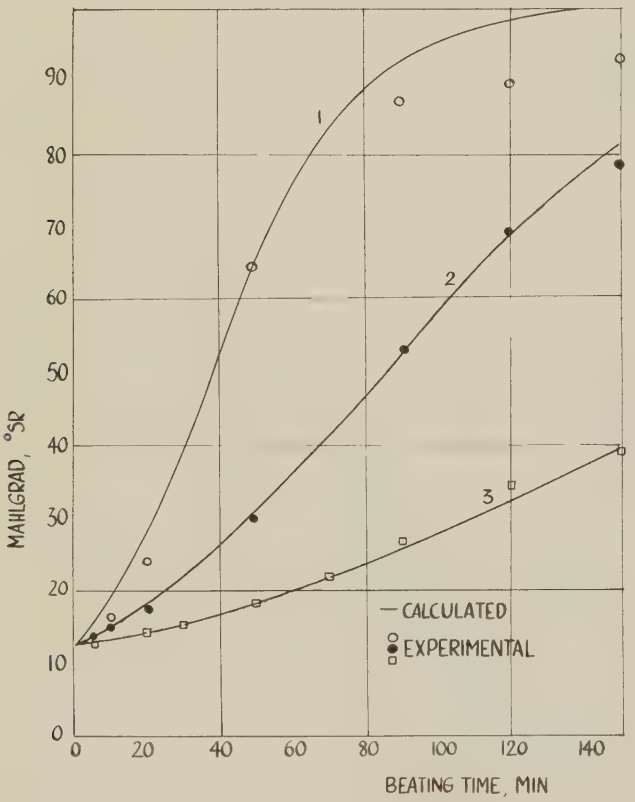

Fig. 7

DISCUSSION

It may be emphasized once more that our explanations concern a special case simplified by the fact that k_r and k_μ are constants. This was found to be true in the case of bleached sulphite pulps. In general, however, the fibrillation rate (k_μ) may depend on the degree of swelling, and the rate of tensile rise (k_r) may depend on the progress of fibrillation. In all cases investigated, using a large variety of pulps and various beaters, the errors did not exceed 6% of the experimental values. A more serious deviation, already mentioned, occurs on fast beating. For high beating times Mahlgrad values were found up to 10° S.R. and breaking lengths up to 1 km. below the calculated values. An effect seems to be inhibiting Mahlgrad and tensile development as beating is extended over longer times.

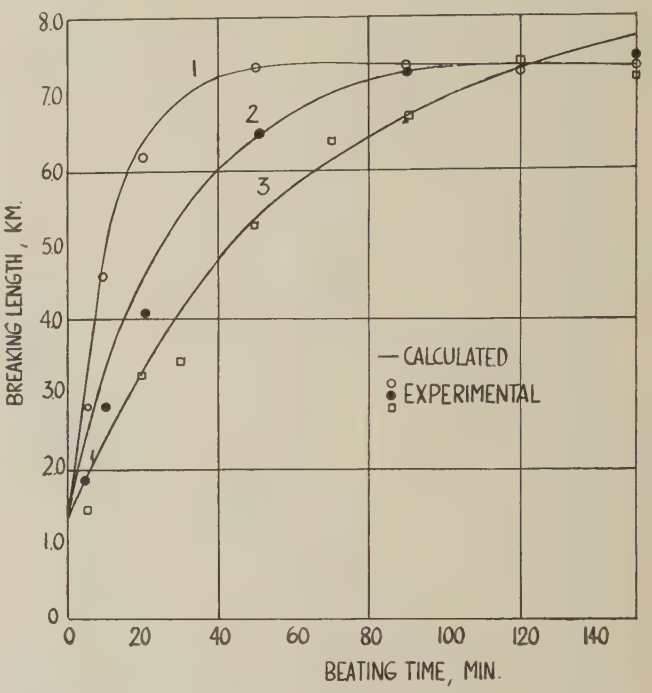

Fig. 8

It can be seen by inspection of equations (2) and (6) that Mahlgrad and tensile strength will always increase with beating time and approach asymptotically maximum values. There will not be maxima followed by a decrease in Mahlgrad or tensile, as is often found in practice.

It should be noted that the radical simplifications made herein only present a preliminary view of the whole problem of comparing pulp and paper properties as given by sets of test data. To obtain a better agreement with practical experience and a more general understanding of the complicated relationships involved, detailed studies will be necessary considering also other effects such as fiber shortening, production of fines by the beating process, etc., not considered in the present paper.

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ASSOCIATION NEWS AND EVENTS

TAPPI Coating Conference

The following is the revised program of the Third Coating Conference of the Technical Association of the Pulp and Paper Industry to be held at the Hotel Sherman, Chicago, Ill., May 5–8, 1952.

Meetings of May 5, 1952

J. G. Bullard, Corn Products Sales Co., New York, N. Y. and Norman Kennedy, Corn Industries Research Foundation, New York, N. Y., Chairmen.

Starch Symposium:

1. "The Future Requirements of Starch from the Standpoint of the Paper Coater," by F. H. Frost, Research Manager, S. D. Warren Co., Cumberland Mills, Me.
2. "Fundamental Developments in Starches for Paper Coating," by T. J. Shock, Corn Products Refining Co., Argo, Ill.
3. "Modifying the Flow of Starch-Sized Coatings," by W. C. Gallagher, Technical Service, A. E. Staley Mfg. Co., Decatur, Ill.
4. "Water-Resistant Starch Coatings," by W. C. Black, Research & Development Dept., Penick & Ford, Ltd., Cedar Rapids, Iowa.
5. "Dextrines and Their Use as Coating Adhesives," by T. A. White, Chief Chemist, General Laboratory, National Starch Products, Inc., New York, N. Y.
6. "Oxidized Starches for the Paper Industry," by J. M. Newton, Director, Technical Sales Service, Clinton Foods, Inc., Clinton, Iowa.
7. "Fundamentals of Adhesives," by G. M. Kline, Chief, Division of Organic and Fibrous Materials, National Bureau of Standards, Washington, D. C.
8. "Use of the Corn Industry Viscometer for the Evaluation of Starches and Enzymes," by M. J. Mason, Section Director, Corn Products Section, Central Research Dept., Anheuser-Busch, Inc., St. Louis, Mo.

Meetings of Tuesday, May 6, 1952

MORNING SESSION

C. C. Kesler, Penick and Ford, Ltd., Inc., Cedar Rapids, Iowa, Moderator,

Panel Discussion on the "Use of Starch in Paper Coating" (Panel members will be the speakers at the previous day's session.)

Coating Conference Luncheon—the speaker will be Peter J. Massey, Chicago, Ill.

AFTERNOON SESSION

F. E. Culp, Consolidated Water Power and Paper Co., Wisconsin Rapids, Wis., Chairman.

1. "Some Engineering Aspects of Coating Preparation" (title tentative), by J. T. Loomer, Robert Gair Co., New London, Conn.
2. "Large Scale Preparation of Clay Slips," by H. M. Hughson, Provincial Paper Ltd., Port Arthur, Ont., and E. G. Heslop, Abitibi Power & Paper Co., Ltd., Sturgeon Falls, Ont.
3. "Enzyme Treatment of Hi-Solids Starch-Pigment Mixtures," by J. E. Wilber, St. Regis Paper Co., Deferiet, N. Y.

Meetings of Wednesday, May 7, 1952

F. E. Culp, Consolidated Water Power and Paper Co., Wisconsin Rapids, Wis., Chairman.

MORNING SESSION

Symposium on Evaluation of Printing Quality of Coated Papers:

1. "Survey of Methods for Evaluating Letterpress Printing Quality" (title tentative), by A. C. Zettlemoyer, National Printing Ink Research Institute, Bethlehem, Pa.
2. "The Toughest Job in the Workd," by R. C. Hydell, The Mead Corp., Chillicothe, Ohio.
3. "Evaluating Coated Surfaces for Lithography—Some Quick and Dirty Methods for Printers," by O. H. Somers, Western Printing & Lithographing Co., Racine, Wis.

AFTERNOON SESSION

1. "A Rheological System for Analyzing the Flow Properties of Pseudoplastic and Thixotropic Pseudoplastic Materials," by R. N. Thompson and G. D. Hansen, Calgon, Inc., Pittsburgh, Pa.
2. "Hot Resin Coated Papers as Barrier Materials," by L. F. Swec and L. M. Burgess, H. P. Smith Paper Co., Chicago, Ill.
3. "Pick Testing of Offset Papers II," by Gordon C. Wheeler and Robert F. Reed, Lithographic Technical Foundation, Chicago, Ill.

On Thursday, May 8, 1952, there will be organized visits to the plants of the Corn Products Refining Co., Argo, Ill., and to the American Maize Products Co., Chicago, Ill. Other visits to printing plants are being arranged.

Reservations for rooms at the Hotel Sherman, Randolph and Clark Streets, Chicago, Ill., should be made direct with John Vidovic, Director of Sales.

Folding Box Conference

The TAPPI Lake Erie Section and the Technical Committee of the Folding Box Association of America will jointly sponsor a conference at the Statler Hotel, Cleveland, Ohio on May 22–23, 1952. A feature of the meeting will be visits to folding box plants in the Cleveland area, including a visit to the Ohio Boxboard Co. mill at Rittman, Ohio. There will be an exhibit of machines used for quality and routine control tests.

The technical program will include papers on problems dealing with:

1. Folding Boxboard Manufacture
2. Folding Box Manufacture
3. Customer Specifications for Folding Boxes
4. Folding Box Use
5. Establishment of a Folding Box Quality Control Program
6. Using a Quality Control Program
7. Establishment of a Cooperative Effort Toward Technological Improvements in the Folding Box Industry.
8. Other Needs of the Folding Box Industry

In addition there will be panel discussions. The membership of the panels will include representatives of a cross section of the industry to assure the discussions being as comprehensive as possible for all types and sizes of folding box plants.

All interested individuals are invited to attend the conference. Membership in TAPPI or the Folding Box Association will not be a requisite for attendance.

Reservations for the conference and hotel accommodations should be addressed to the TAPPI Lake Erie Section, 1200 West Ninth Street, Cleveland 13, Ohio.

Report of the Secretary

The Technical Association of the Pulp and Paper Industry continued to grow at a rapid rate in 1951. The Annual Meeting and the six functional meetings all had large and representative attendance.

Membership

There were 655 individual members elected in 1951. 234 resigned or were dropped from the membership. On Dec. 31, 1951, the total individual membership was 4689.

There were 12 corporate members elected. Six corporate members resigned. The corporate membership on Dec. 31, 1951, was 227.

There were 12 sustaining members elected in 1951. Seven sustaining members resigned. The sustaining membership on Dec. 31, 1951, was 192.

The following companies became corporate members in 1951:

Atlanta Paper Co., Atlanta, Ga.
Cebu Portland Cement Co., Manila, Philippines
"Cellunaf," Cie Nord-Africaine de Cellulose, Algiere, N. A.
Kalamazoo Ltd., Birmingham, England
Kansazi, Paper Mfg. Co. Ltd., Tokyo, Japan
Perlen Paper Mill, Lucerne, Switzerland
Portuguesa de Celulose Ca., Lisbon, Portugal
Potlatch Forests, Inc., Lewiston, Idaho
Technical Development Establishment Stores, New Delhi, India
Technical University Engineering Library, Praha, Czechoslovakia
Wiggins, Teape & Co. Ltd., Woburn Green, Bucks., England

The following companies became sustaining members in 1951:

Louis Allis Co., The, Milwaukee, Wis.
American Key Products, Inc., New York, N. Y.
Clark-Aiken Co., The, Lee, Mass.
Ebasco Services, Inc., New York, N. Y.
H. K. Ferguson Co., The, Cleveland, Ohio
Hauser-Stander Tank Co., The, Cincinnati, Ohio
John Inglis Co. Ltd., Toronto, Ont., Canada
Magnus Chemical Co., Inc., Garwood, N. J.
Morningstar, Nicol, Inc., New York, N. Y.
Pfeifer & Shultz, Minneapolis, Minn.
Ranney Method Water Supplies, Inc., Columbia, Ohio
Tremont Lumber Co., Chicago, Ill.

Necrology

The Association lost the following members through death:

Eugene N. Bechard, Broker, Atlanta, Ga.
George H. Becker, Cellulose Development Corp., Hatch End, Middlesex, England
F. Paul Birk, Consulting Engineer, Chicago, Ill.
Roger M. Braunstein, S. A. des Anciens Establissment Braunstein Freres, Paris, France
Harold F. Bullard, Finch Pruyn & Co., Inc., Glens Falls, N. Y.
L. A. Carpenter, Bergstrom Paper Co., Neenah, Wis.
William M. Cary, National Container Corp., Jacksonville, Fla.
Harold F. Cotter, University of Alabama, University, Ala.
Leon Dixon, Consultant, Bangor, Me.
John W. Donohue, Blackstone Glazed Paper Co., Pawtucket, R. I.
L. V. Frisch, Fir-Tex Insulating Board Co., St. Helens, Ore.
Grant L. Geisinger, Northwest Filter Co., Seattle, Wash.
Jalmar Heisakanen, Rauma-Raahe OY, Kangasniemi, Finland
Hans Heller, Papierfabrik Weissenstein A. G., Pforzheim, Germany
Robert J. Meagher, Folding Paper Box Assn. of America, Chicago, Ill.
Charles W. Morden, Morden Machines Co., Portland, Ore.
Peter Paulson, Consulting Engineer, Encinitas, Calif.
Robert T. Petrie, The Black-Clawson Co., Portland, Ore.
Charles W. Rivise, Patent Attorney, Philadelphia, Pa.
William M. Shoemaker, Jr., Broker of Specialty Foods, Tucson, Ariz.
Fritz Stockigt, Felix Heinr. Schoeller, Duren Rhineland, Germany
H. van der Raay, Geldecor Africa (Pty) Ltd., Transvaal, S. A.
Eric Wahlforss, Wartsila Cellulose A/B, Aanekoski, Finland
Gunnar E. Weckstrom, Kymmene A/B Kuusankoko, Finland
George Welp, Interchemical Corp., New York, N. Y.
George E. Williamson, Strathmore Paper Co., West Springfield, Mass.

Meetings of the Association

In addition to the Annual Meeting six functional meetings sponsored by committees of the Association were held.

1951 Annual Meeting

The Annual Meeting was held at the Commodore Hotel on Feb. 19–22, 1951. More than 1500 registered. One hundred eighteen papers were presented. The annual luncheon was featured by an address by J. D. Zellerbach, President of the Crown Zellerbach Paper Co., San Francisco, Calif., on "The Technique of Freedom" in which he reviewed his experiences with labor in Italy. The TAPPI Medal was presented to George H. Tomlinson of the Howard Smith Paper Mills, Ltd., Montreal, Que. The presentation was made on behalf of the Association by J. Newell Stephenson, Editor of the *Pulp and Paper Magazine of Canada.*

Second Coating Conference

The Association departed from its practice of holding all of its functional meetings in the Fall. The Second Coating Conference of the Paper Industry was held at the Statler Hotel, Boston, Mass., on April 18–20, 1951, under the sponsorship of the TAPPI Coating Committee, J. H. Heuer, then with A. P. W. Products, Inc., Chairman. A. D. Bonanno of the Champion-International Paper Co., Lawrence, Mass., was Program Chairman and R. T. Trelfa, then of Hercules Powder Co., Wilmington, Del., was Chairman of the Raw Stock Symposium. The Conference featured a Symposium on Raw Stock Requirements for Coated Paper and Paperboard. The luncheon speaker was George Olmsted, Jr., President of the S. D. Warren Co., Boston, Mass., who talked on "Feast or Famine." Fifteen technical papers were presented.

Corrugated Combining Conference

On May 18, 1951, the Corrugated Containers Committee sponsored a Corrugated Combining Conference at the Statler Hotel, Cleveland, Ohio. F. D. Long of The Container Corp. of America was coordinator of the conference at which four papers were presented. William Schoenberg of Lord & Schoenberg was in charge of registration.

Following the conference the Lake Erie Section of TAPPI received its charter from the national organization. Principal addresses were given by R. P. Price of the Hammermill Paper Co., Erie, Pa., representing the TAPPI Executive Committee and R. G. Macdonald, Secretary of TAPPI.

Fundamental Research Conference

The month of September was a strenuous one for research chemists. Early in the month the 75th anniversary of the American Chemical Society and the World Chemical Congress were held in New York and Washington. At these meetings many American and foreign scientists presented papers dealing with cellulose chemistry and lignin. A group of about 40 European technical men continued their stay in the United States by attending meetings sponsored by TAPPI and the Pulp and Paper Research Institute of Canada. In addition a few of these individuals addressed other functional meetings of TAPPI and some of its local sections.

On September 17–21 at The Institute of Paper Chemistry in Appleton, Wis., the TAPPI Fundamental Research Committee in cooperation with the Institute and the U. S. Food and Agriculture Organization held an international symposium. September 17 and 18 were devoted to a thorough review of the "Pulping of Tropical Woods and the Chemical Utilization of Agricultural Residues" for the F.A.O. The meetings of September 19 and 20 were devoted to a variety of technical papers including panel discussions on "Spent Sulphite Liquor Utilization" and "Pilot Plants for the Paper Industry." September 21 was devoted to a round-table discussion of "Lignin and Wood Extractives." Harry F. Lewis of The Institute of Paper Chemistry and Chairman of the TAPPI Fundamental Research Committee was General Chairman of the Conference.

Fifth Alkaline Pulping Conference

The Alkaline Pulping Committee sponsored the Fifth Alkaline Pulping Conference at the John Marshall Hotel,

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Richmond, Va., on Sept. 26–28, 1951. Henry Vranian of the Chesapeake Corp. of Va., West Point, Va., and Chairman of the TAPPI Alkaline Pulping Committee was General Chairman of the Conference. Robert R. Fuller of the Gulf States Paper Co., Tuscaloosa, Ala., was Program Committee Chairman. A. P. Yundt of the Camp Mfg. Co., Franklin, Va., was in charge of registration. G. R. Tennant of the Continental Can Co., Hopewell, Va., was in charge of transportation and M. G. Selden of the Albermarle Paper Co., Richmond, Va., was in charge of publicity.

The conference featured symposia on "Wood Room Operation" and "Pulp Cooking." A visit was made to the mill of the Chesapeake Corp. at West Point, Va., and the meeting ended with a luncheon at the Williamsburg Inn, Williamsburg, Va., sponsored by the Sutherland Refiner Corp. of Trenton, N. J.

Sixth Engineering Conference

The Sixth Engineering Conference of the Pulp and Paper Industry was held at the General Oglethorpe Hotel, Wilmington Island, Savannah, Ga., on Oct. 15–18, 1951. This conference followed similar meetings at Milwaukee, Philadelphia, Buffalo, Boston, and Cincinnati.

This meeting was successful, as were its predecessors, in attracting about 700 pulp and paper mill engineers from the United States and Canada. George H. Pringle of the Mead Corp., Chillicothe, Ohio, was General Chairman of the Conference. J. R. Lientz of the Union Bag & Paper Corp., Savannah, Ga., was in charge of local arrangements.

The technical program was arranged by the committees of the Engineering Division. Steam and Power, Materials Handling, Drying and Ventilating, Mill Design and Economic Aspects, Mill Maintenance and Materials, Electrical Engineering, Chemical Engineering, Hydraulics and Engineering Research and Machine Design Committees. J. E. Tobey of Appalachian Coals, Inc., Cincinnati, Ohio, was the luncheon speaker and discusser "Design Trends in Boiler Installations in the Pulp and Paper Industry of the South." On the final day of the meeting visits were made to the mills of the Union Bag & Paper Corp. and the Southern Paperboard Corp. A barbecue luncheon was given by the Union Bag & Paper Corp. at the Mary Calder Golf Club in Savannah.

Plastics Conference

The Plastics Committee sponsored a Paper Plastics Conference in The Baker Auditorium, College of Forestry, State University of New York, Syracuse, N. Y., on Nov. 8–9, 1951. E. C. Jahn of the College of Forestry and Chairman of the TAPPI Plastics Committee was General Chairman of the Conference. R. T. Nazzaro of the Westfield River Paper Co., Russell, Mass., conducted a Symposium in "Plastic Coatings and Barriers" and C. J. Straka of the Westinghouse Electric Corp., Trafford, Pa., conducted a session on "Paper-Plastic Structural and Lamination Products."

Publications of the Association, Tappi

Tappi, the monthly technical magazine of the Association, completed its third successful year in December, 1951. In June, 1951, at the National Industrial Advertisers Association Meeting, the publication received the first prize plaque for editorial achievement for Class, Institutional, and Professional Papers for publishing the best series of articles during the period ending Dec. 31, 1950. This award was made by the publication *Industrial Marketing* who sponsored our editorial competition participated in by more than 600 publications. The publication leading to this award were the papers presented during the Fundamental Research Conference at Quebec, P. Q., in 1950.

Bibliography of Paper Making

The Bibliography of Paper Making was issued in 1951 as a collective bibliography covering the years 1946–50, inclusive. The patents for 1950 were omitted and will be published in combination with the 1951 patents in the 1952 annual. C. J. West, Chairman of the TAPPI Bibliography Committee, continued as the compiler of the 1946–50 work.

TAPPI Standards

One new tentative standard and three new suggested methods were approved during the year. Revisions of two official standards were approved. The Book of Standards now includes 13 recommended practices, 5 specifications, 158 testing methods, and 15 suggested methods.

Routine Control Methods

Very little progress was made during the year in establishing new routine control methods. There are at present 151 methods available. Most of these were obtained as a result of a concerted drive. During the past year a special effort was made to induce the local sections to take over the responsibility of obtaining new methods. Toward the end of the year some progress was noted in this regard and several methods have been received during the past few months.

TAPPI Data Sheets

The progress in preparing Data Sheets has also been slow but several new sheets were obtained during the latter part of 1951 from the Drying and Ventilating and the Electrical Engineering Committees. These will be distributed early in 1952.

Monographs

A monograph on "Machinery for Paper Coating" was issued in 1951. A Monograph on "Adhesives for Paper Coating" is at the printer and will be issued this Spring.

TAPPI Medal Award

The 1951 TAPPI Medal was presented to George H. Tomlinson of the Howard Smith Paper Mills, Ltd., Montreal, Que.

TAPPI Fibrary

The TAPPI Fibrary is located at The Institute of Paper Chemistry, Appleton, Wis., and has been exceptionally well handled by Irving H. Isenberg of the Institute staff. There is a need for more fiber samples, especially of lesser known fibers. Individuals desiring fiber samples for microscopy determinations can obtain them from Dr. Isenberg.

Employment

Toward the end of 1951 the growing manpower shortage began to become apparent in the Employment Service registrations in *Tappi*. This situation is certain to continue in 1952. The Employment Service is performing an important function and accounts for a rather large volume of correspondence with the Association office. The Association has always felt that the employment clearing house is an important Association service and makes a special effort to expedite correspondence relating to this subject. During 1951 most of the individuals seeking employment were able to obtain it. There were almost no unemployed members but many changed positions.

Local Sections

The Lake Erie Section received its charter as a local section of the Association on May 18, 1951, at the Statler Hotel, Cleveland, Ohio.

A new group, temporarily designated as the Southeastern Pulp and Paper Society, was established at a meeting held at the Dempsey Hotel, Macon, Ga., on May 4, 1951. Glenn C. Kimble of the Union Bag & Paper Corp., Savannah, Ga., presided as Chairman.

The chairmen of the local sections elected during 1951 were as follows:

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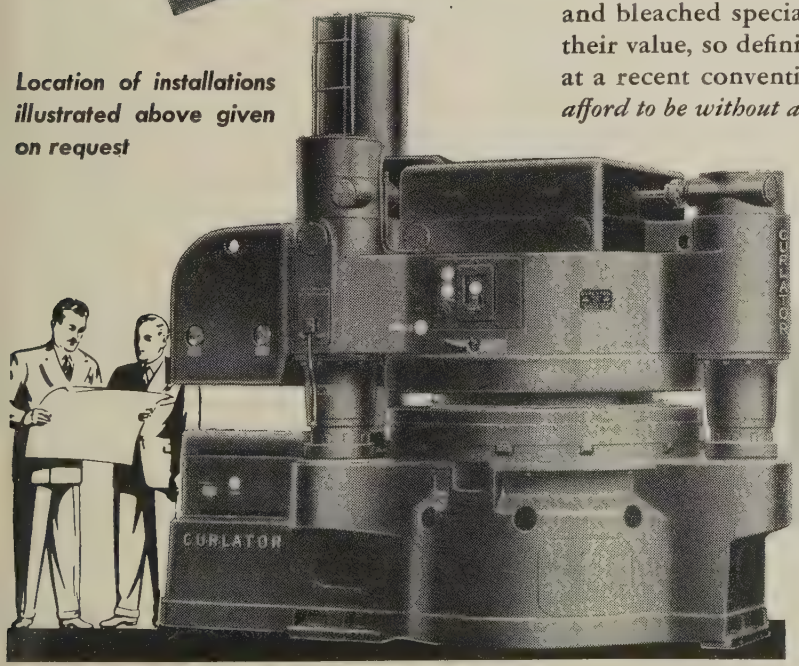

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Lake States—Alan P. Adrian, Neenah Paper Co., Neenah, Wis.
Delaware Valley—A. S. Erspamer, P. H. Glatfelter Co., Spring Grove, Pa.
Kalamazoo Valley—John R. Dam, Allied Paper Mills, Kalamazoo, Mich.
New England—H. W. Knudson, Hollingsworth & Vose Co., East Walpole, Mass.
Ohio—Herbert A. Smith, Mead Corp., Chillicothe, Ohio
Empire State—J. S. Reichert, E. I. du Pont de Nemours & Co., Inc., Niagara Falls, N. Y.
Maine-New Hampshire—George A. Day, Brown Co., Berlin, N. H.
Chicago—Vance V. Vallandigham, Kelco Co., Chicago, Ill.
Lake Erie—William A. Hasselo, Container Corp. of America, Cleveland, Ohio
Papermakers and Associates of Southern California (unaffiliated)—Wm. C. Birdsey, Pioneer-Flintkete Co., Los Angeles, Calif.

Divisions and Committees

The divisions and committees of the Association were with few exceptions quite active in 1951. Their accomplishments are reflected in the large number of papers presented at the Annual and functional meetings of the Association as well as in the monographs, standards, data sheets, etc., developed by them for the benefit of the industry. The following information is devoted, for the most part, to the chairmanship personnel and changes made during the year.

Engineering Division: George H. Pringle, Mead Corp., Chillicothe, Ohio, General Chairman and J. W. Hemphill, Johns-Manville Corp., New York, N. Y., General Secretary, were succeeded in October, 1951, by Charles R. Sibler, West Virginia Pulp & Paper Co., New York, N. Y., and W. C. Bloomquist, General Electric Co., Schenectady, N. Y., as General Chairman and General Secretary, respectively. *Steam and Power Committee:* C. R. Sibler, Chairman, was succeeded in October, 1951, by H. R. Arnold, Riegel Carolina Corp., Acme, N. C., as chairman. *Materials Handling Committee:* A. P. Schnyder, Ebasco Services, Inc., New York, N. Y., Chairman. *Drying and Ventilating Committee:* M. L. Barker, Beckett Paper Co., Hamilton, Ohio, Chairman. *Engineering Research and Machine Design Committee:* John D. Lyall, Armstrong Cork Co., Lancaster, Pa., Chairman. This committee has four subcommittees: *Centralized Control of Stock System Subcommittee*, L. A. Moore, American Coating Mills, Elkhart, Ind., Chairman; *Methods for Quickly Estimating Costs of Engineering Projects Subcommittee*, H. T. Ingraham, Chas. T. Main, Inc., Boston, Mass., Chairman; *Correlation of Various Types of Plastometers Subcommittee*, K. W. Brenner, Eastman Kodak Co., Rochester, N. Y., Chairman; *Standardization of Machine Parts Subcommittee*, G. E. Clink, Sandy Hill Iron & Brass Works, Hudson Falls, N. Y., Chairman. *Hydraulics Committee:* K. J. Mackenzie, Eastman Kodak Co., Rochester, N. Y., Chairman. *Mill Design and Economic Aspects Committee:* Roland A. Packard, National Production Authority, Washington, D. C., Chairman. *Mill Maintenance and Materials Committee:* H. F. Parker, New York & Pennsylvania Co., Lock Haven, Pa., Chairman. *Chemical Engineering Committee:* J. R. Lientz, Union Bag & Paper Corp., Savannah, Ga., Chairman. Mr. Leintz is also chairman of the *Digester Corrosion Subcommittee. Electrical Engineering Committee:* R. W. Foster, Champion Paper & Fibre Co., Canton, N. C., Chairman. *Cable Subcommittee:* A. O. Mortenson, St. Regis Paper Co., Pensacola, Fla., Chairman. *Data Sheets Committee:* Henry J. Perry, *Paper Trade Journal, Chairman.*

Industrial Division: Werner Kaufmann, retired, was succeeded by R. W. Kumler, American Cyanamid Co., New York, N. Y., as General Chairman. *Vocational Education Committee:* B. E. Lauer, University of Colorado, Chairman. *Nonfibrous Raw Materials Committee:* E. N. Poor, Hudson Pulp & Paper Co., Augusta, Me., Chairman. *Mill Instrument Control Committee:* No Chairman. *Water Committee:* A. S. Erspamer, P. H. Glatfelter Co., Spring Grove, Pa., Chairman. *Fibrous Agricultural Residues Committee:* S. I. Aronovsky, Northern Regional Research Laboratory, Peoria, Ill., Chairman. *Structural Fibrous Materials Committee:* E. M. Jenkins, Johns-Manville Corp., Manville, N. J., Chairman.

Converting and Consuming Division: Martin L. Downs, Thilmany Pulp & Paper Co., Kaukauna, Wis., Chairman. *Corrugated Containers Committee:* F. D. Long, Container Corp. of America, Chicago, Ill., Chairman. *Graphic Arts Committee:* F. D. Elliott, Time, Inc., Springdale, Conn., Chairman. *Wet Strength Committee:* K. W. Britt, Scott Paper Co., Chester, Pa., Chairman. *Coating Committee:* J. H. Heuer, Great Northern Paper Co., Millinocket, Me., Chairman. *Plastics Committee:* E. C. Jahn, College of Forestry, State University of New York, Syracuse, N. Y., Chairman.

Research Development Division: Walter F. Holzer, Crown Zellerbach Corp., Camas, Wash., succeeded H. W. Bialkowsky, Pulp Div., Weyerhaeuser Timber Co., Longview, Wash., as General Chairman. *Bibliography Committee:* C. J. West, Institute of Paper Chemistry, Appleton, Wis., Chairman. *Fundamental Research Committee:* H. F. Lewis, Institute of Paper Chemistry, Appleton, Wis., Chairman. *Statistics Committee:* John F. Langmaid, Jr., S. D. Warren Co., Cumberland Mills, Me., succeeded T. A. Pascoe, Nekoosa-Edwards Paper Co., Port Edwards, Wis., as Chairman. *Microbiological Committee:* R. F. DeLong, Marathon Corp., Rothschild, Wis., Chairman. *Patents Committee:* Frank Makara, Patent Attorney, New York, N. Y., Chairman.

Pulp Manufacture Div.: K. O. Elderkin, Crossett Paper Mills, Crossett, Ark., succeeded F. C. Goodwill, St. Regis Paper Co., Kalamazoo, Mich., as General Chairman. *Acid Pulping:* J. M. McEwen, Pulp Div., Weyerhaeuser Timber Co., Everett, Wash., Chairman. *Mechanical Pulping Committee:* F. W. O'Neil, College of Forestry, State University of New York, Syracuse, N. Y., Chairman. *Alkaline Pulping Committee:* Henry Vranian, Chesapeake Corp. of Va., West Point, Va., Chairman. *Chemical Products Committee:* Aurthur Pollak, Consultant, New York, N. Y., Chairman. *Paper Deinking Committee*: James J. Forsythe, International Paper Co., Niagara Falls, N. Y., Chairman. *Pulp Purification Committee:* W. D. Harrison, Riegel Paper Corp., Milford, N. J., Chairman.

Paper Manufacture Division: R. P. Price, Hammermill Paper Co., Erie, Pa., succeeded A. L. Sherwood, Sutherland Paper Co., Kalamazoo, Mich., as General Chairman. *Preparation of Papermaking Materials Committee:* F. S. Klein, Byron Weston Co., Dalton, Mass., Chairman. *Paper Making (Cylinder) Committee:* J. J. Harrison, Michigan Carton Co., Battle Creek, Mich., Chairman. *Paper Making (Fourdrinier) Committee:* N. R. Phillips, Champion Paper & Fibre Co., Canton, N. C., Chairman.

Testing Division: James d'A. Clark, Research Development Engineer, Longview, Wash., General Chairman. *Fibrous Materials Testing Committee:* E. R. Schafer, Forest Products Laboratory, Madison, Wis., Chairman. *Nonfibrous Materials Testing Committee:* J. P. Casey, A. E. Staley Mfg. Co., Chairman. *Wax Testing Committee:* A. M. Heald, Scott Paper Co., Chester, Pa., Chairman. (This committee is also the TAPPI-ASTM Joint Committee on Petroleum Wax.) *Pulp Testing Committee:* L. V. Forman, Scott Paper Co., Chairman. *Optical Products Committee:* H. E. Obermanns, Hammermill Paper Co., Erie, Pa., succeeded A. H. Croup of the same company as chairman. *Microscopy Committee:* C. E. Brandon, Howard Paper Mills, Dayton, Ohio, Chairman. *Paper Testing Committee:* A. K. Warner, Consultant, Boston, Mass., Chairman. (Mr. Warner will be succeeded by D. H. Newcomb, Riegel Paper Corp., Milford, N. J. at the Annual Meeting in February, 1952.) *Container Testing Committee:* C. H. Krebs, Atlas Boxmakers, Inc.,

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CARDIS® 314	184-189	4-6	4-5	13-15	45-50	EMULSIFIABLE PETROLEUM WAX
CARDIS® 319	180-185	5-7	4½-6	18-20	65-70	EMULSIFIABLE PETROLEUM WAX
CARDIS® 320	180-185	5-7	4-5	30-32	80-85	EMULSIFIABLE PETROLEUM WAX
CARDIS® 262	195-200	4-6	BROWN	14-16	40-45	SPECIALLY PROCESSED PETROLEUM WAX
FORTEX®	190-200	3-5	2½-3½	0.0	0.0	MICRO-CRYSTALLINE HARD AND PLASTIC
MEKON® B-20 MEKON® A-20 MEKON® Y-20	190-195 190-195 190-195	3-5 3-5 3-5	BROWN-BLACK AMBER-6 MAX. YELLOW-3-3½	0.0	0.0	MICRO-CRYSTALLINE HARD AND BRITTLE
WARCO® WAX 180	180-185	4-7	WHITE	0.0	0.0	MICRO-CRYSTALLINE HARD AND BRITTLE
WARCO® WAX 150	145-150	20-25	BROWN YELLOW	0.0	0.0	MICRO-CRYSTALLINE PLASTIC
WARCOSINE®	145-150	15-20	WHITE	0.0	0.0	MICRO-CRYSTALLINE PLASTIC
PARAFFIN	131-133	FULLY REFINED				CRYSTALLINE
SUGAR CANE WAX	174-178	2 MAX.	TAN	23-28	65-77	VEGETABLE WAX

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Chicago, Ill., succeeded W. J. Balster, Don L. Quinn Co., Chicago, Ill., as Chairman. *Packaging Materials Testing Committee:* L. E. Sinneral, Marathon Corp., Menasha, Wis., Chairman. *Chemical Methods Committee:* A. S. O'Brien Eastman Kodak Co., Rochester, N. Y., Chairman.

Special Committees: *Standards Committee:* R. C. Griffin, Consultant, Needham, Mass., Chairman. *Research Appropriations Committee:* J. L. Parsons, Hollingsworth & Whitney Co., Waterville, Me., Chairman. *Joint Textbook Committee:* H. S. Spencer, Howard Smith Paper Mills, Ltd., Beauharnois, Que., Canada, Chairman. The other members of this committee are R. S. Hatch, Hudson Pulp & Paper Co., Palatka, Fla., Douglas Jones, Technical Section, C.P.P.A., R. G. Macdonald, TAPPI New York N. Y., and R. S. Kellogg, Bradenton, Fla., Secretary. J. N. Stephenson is Editor.

R. G. Macdonald, Secretary TAPPI

TAPPI Medal to Ray Hatch

The twentieth TAPPI Medal was presented to Raymond S. Hatch, Research Director of the Hudson Pulp & Paper Co., Palatka, Fla., at the annual luncheon of the Technical Association held at the Commodore Hotel, New York, N. Y., on Feb. 21, 1952. Robert B. Wolf, retired, and formerly of the Pulp Division, Weyerhaeuser Timber Co. (now residing in New Canaan, Conn.), made the official presentation on behalf of the Executive Committee of the Association. The remarks of Messrs. Wolf and Hatch follow.

R. B. Wolf

Presentation Remarks by Mr. Wolf

I don't know anyone in the Pulp and Paper Industry that I would rather present the 1952 TAPPI Award to than Ray Hatch. I have known Ray, both as a friend and as a business associate, for almost 40 years so I have had a pretty good opportunity to evaluate the many contributions he has made to the industry.

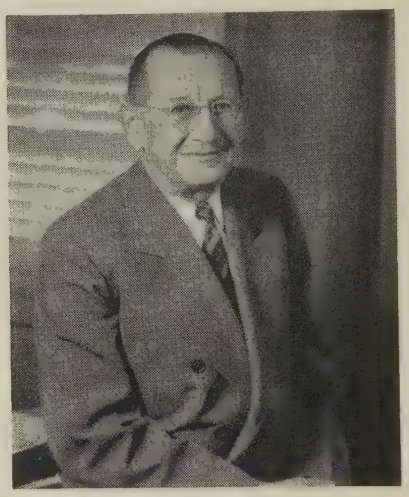
Ray Hatch was the first chemist on the payroll of any paper company in the entire Connecticut Valley. It was Frank McElwain of the Crocker, McElwain Co., in Holyoke, Mass., who first took the gamble in 1912 that a chemist might be of some value to the paper industry around Holyoke.

Actually McElwain was not taking much of a chance—at least not with Ray Hatch. Ray had graduated from Syracuse University in 1904 *Magna Cum Laude*, and with a Phi Beta Kappa key. Instead of going back to his home in Watertown after graduation, he worked one year as private assistant to Professor F. J. Moore, Head of the Department of Organic Chemistry at the Massachusetts Institute of Technology. Then followed two jobs in industry before joining Crocker, McElwain: organic chemist and assistant manager of Ozone Vanillan Co. in Niagara Falls and operating head of one of the departments of Heller & Merz Co., manufacturers of dyestuffs in Newark, N. J.

It was while Hatch was in charge of manufacturing at Crocker, McElwain, and I was managing the Burgess Sulphite Fiber Co., that we first met. At Berlin we had been trying to evaluate the pulp-making qualities of wood pulp by the "ball mill methods." At Holyoke, Hatch was using a laboratory form of beater, plotting Mullen against time.

Hatch explained that his efforts were directed toward the development of a pulp which would enable him to reduce a large number of qualities or grades (15 in all at Crocker-McElwain) to 2 or 3 grades. He said he wanted a pulp which was flexible and soft and yet strong and durable enough to stand hard working in the beaters. He said, of course, it had to be bright in color, clean, and above all, uniform in its physical properties. A pulp, in short, that had the "guts" to stand the treatment he had to give it when blended with rag stock. Hatch's consistent prodding to obtain this goal was what finally enabled us to attain a "standard" pulp that permitted him to cut his pulp stocks from 15 grades to 3 out of which, because of its dependability, he could produce over 90% of the papers made in a high-grade specialty mill. Hatch taught us that the most important "quality" in pulp is its uniformity. He insisted that the papermaker had enough variables to contend with without having them show up in his principal raw material.

In 1919, Hatch became Manager of Manufacturing of the Hammersley Mfg. Co., at Garfield, N. J. From there he joined the Mead Corp. to assist in the design of the Fraser Co.'s first paper mill at Madawaska, Me. which mill he started up upon its completion. After a period of consulting work in the pulp and paper field, he became Research Director of the Pulp Bleaching Corp. where he proceeded to lay a firm scientific foundation under the art of bleaching wood pulp. In fact he took most of the mystery out of bleaching.



R. S. Hatch

In 1932 he became Director of Research of the Pulp Division of the Weyerhaeuser Timber Co. at Longview, Wash., confirmed and expanded his work on bleaching in both the sulphite and sulphate fields, carried on extensive research on cooking various species of wood made by both the acid and alkaline processes. Simultaneously, he carried on a program of pulp purification which resulted in the production of high quality dissolving pulp of outstanding uniformity.

Weyerhaeuser's recent big expansion of pulp production from Douglas-fir sawmill waste is based upon research work carried on under Ray Hatch's direction. The successful solution of the sulphite waste liquor recovery program by the use of magnesium base was developed while Hatch was in charge of this work. In fact the research department established at Weyerhaeuser is one of the finest examples of applied research in our industry.

In conclusion I want to emphasize the quiet but effective influence Ray Hatch has had in the affairs of TAPPI. He was its President in 1919 and 1920, and has been one of the five members of our Textbook Committee since its formation in 1916. Ray Hatch's outstanding characteristic is his search for truth and particularly its dissemination through the medium of technical literature.

He knows that the mere pursuit of knowledge for one's own individual advantage will not lead to happiness, and that only as we share truth with others can we change the present

Announcing the 1952

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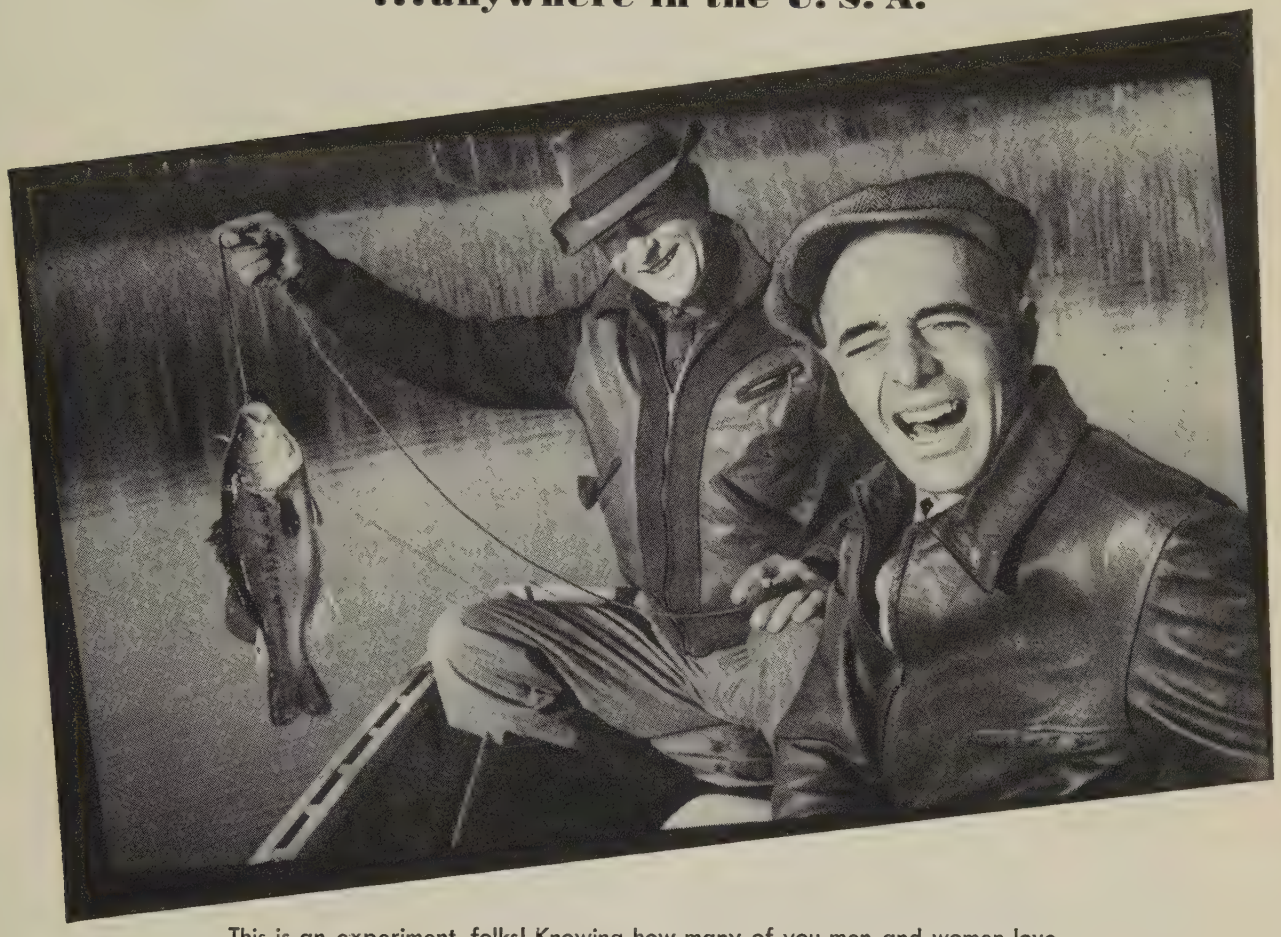

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15—3rd Prizes.....$25 Savings Bond
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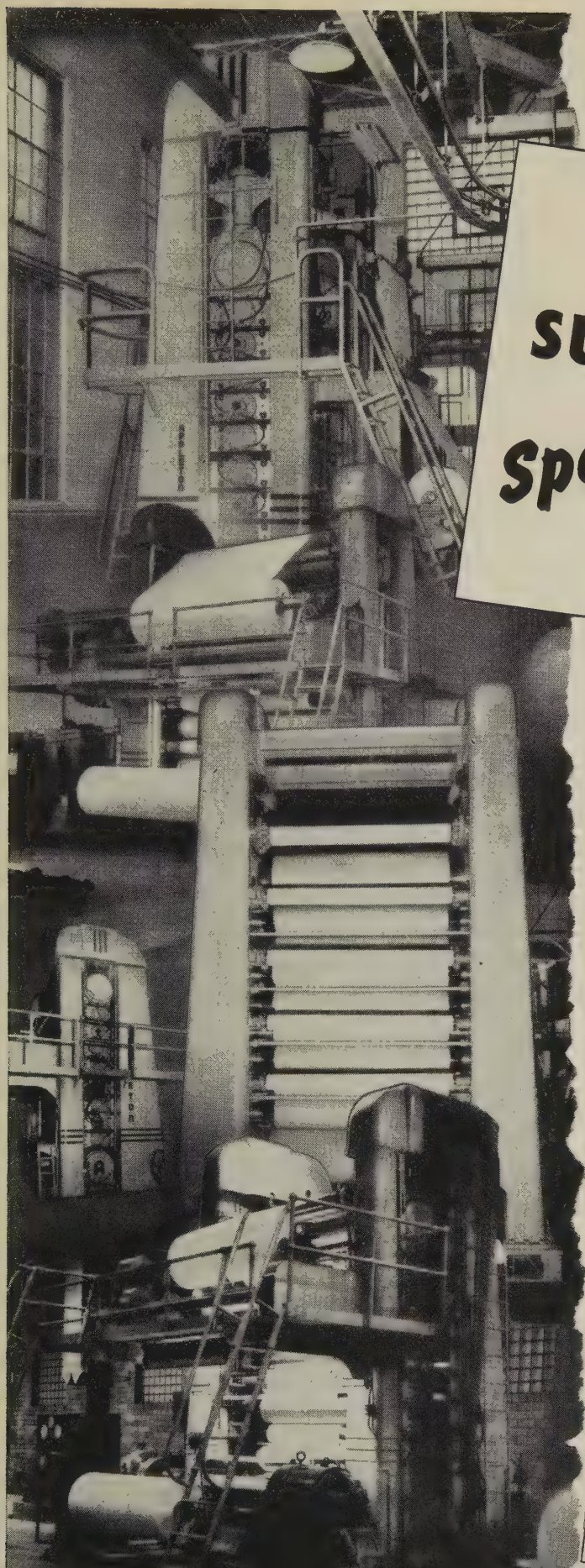
The Annual Luncheon at the 37th Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 21, 1952



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trend of civilization from one of disintegration to something far more constructive than anything the world has yet seen.

Ray, because of your outstanding accomplishments, and because of your inherent modesty and willingness to share with others, I am delighted on behalf of the Executive Committee of the Technical Association to present to you the highest award TAPPI can confer on any man for outstanding contribution to the Pulp and Paper Industry.

Response by Mr. Hatch

Mr. Wolf, President Geohegan, Members of the Executive Committee, and friends. It is indeed an honor to be chosen as the recipient of this high award from TAPPI in recognition

Walter J. Murphy, luncheon speaker, addresses TAPPI on "Scientific and Technical Manpower Problems"

of service rendered to the technical advance of the Pulp and Paper Industry. I happen to be one of those fortunate technically trained men who were to witness the emergence of the Pulp and Paper Industry from the state of an art handed down through many generations to that of a science growing ever more precise with each passing year. It has been a fascinating and stimulating experience to play a small part in the tremendous technical progress of our industry and to note the contributions made by all the recognized branches of science to this progress.

As we consider this constantly expanding industry, some questions naturally arise: What is our future? How shall we meet the ever increasing demands for raw materials? I can only point out some of the steps we are taking and suggest subjects which merit further research and development.

The mechanics of paper production can well be left in the hands of the engineers responsible for the design of papermaking equipment. It is these engineers who have so perfected modern paper machines and so greatly increased production as to place responsibility for the increased supply of raw materials in the hands of our research and development organizations.

The three raw materials necessary for the perpetuation of the industry are cellulose in one form or another, chemicals, and energy. Cellulose is, of course, the basic skeletal substance of all vegetation. It exists in many forms and paper has been made experimentally from thousands of different plants. The Pulp and Paper Industry, must however, select that type of plant life which produces the greatest yield of cellulose per acre and must then see that the most favorable growth conditions are maintained to secure maximum yield.

The forests have proved to be our richest source of cellulose and we must continue to rely upon the forests for our increasing demand for raw materials. In the past we have, however, depended almost entirely on nature for forest reproduction. We even did not give nature any cooperation but recklessly cut away our forests without thought of our future supply.

As we cut our forests we finally had to appeal to trained foresters to help us out. Even the great forest areas of the Pacific Northwest and of the South were destined for exhaustion when forward looking foresters both in Government and private service finally had their warnings heeded and we began the development of tree farms with the idea of assuring ourselves of a continuing supply of trees through intelligent forest management. The tree farm is rapidly becoming accepted practice in all of our forest areas and, if we can keep fires and insect damage to a minimum, we can be assured of a steady supply of raw materials from present forests to meet our present needs.

Under natural conditions of forest growth the stands are frequently too dense to support rapid growth so the practice of thinning is coming into use. Just as the farmer thins an agricultural crop to allow better and more rapid growth of an annual crop, so the forester thins the forest crop to increase the growth rate and produce more cellulose per acre. This thinning or prelogging practice serves another purpose where large diameter mature timber is harvested. It clears the way for the falling of heavy timber without knocking down and destroying the young growth. Proper prelogging methods leave the remaining young forest in best condition for rapid growth.

In the pine forests of the South, where the forest floor is relatively clean and free of underbrush, prelogging and the harvesting of mature timber is a relatively simple operation and is rapidly becoming standard practice. It is of interest to note that the South is now the leading area in the promotion of tree farms. The American Forest Products Industries has recently issued a report which reveals that nearly 25 million acres of southern forest land is now in the form of tree farms.

Up until comparatively recently, the pulp produced in the Pacific Northwest was predominantly sulphite. Western hemlock and the true firs are species especially suited for the manufacture of high-grade sulphite and these species are of little value for lumber. Douglas-fir is the chief lumber species of the Pacific Northwest. It is not successfully pulped by the sulphite process and, until recently, was not considered as an especially good raw material for the sulphate process. The growth of the kraft industry in the South, however, and the striking similarity of Douglas-fir fiber to that of the southern pines stimulated a more thorough investigation of this species for the manufacture of sulphate with the result that Douglas-fir is becoming an important raw material for the pulp industry. In the manufacture of lumber, the sawmill waste is a large item. This waste was formerly hogged and used as fuel but its value as a source of pulp exceeds its value as fuel, consequently, more and more sound Douglas-fir sawmill waste is going into the manufacture of sulphate pulp, thus providing a new source of raw material for the industry.

In considering wood as a raw material the increasing use of the hardwood species should be emphasized. In the early days of the pulp industry the so-called hardwoods or deciduous woods were the principal species pulped by the soda process. With the advent of the sulphite process and the production of sulphite pulp from the long-fibered coniferous woods the soda process began to decline. Bleached soda pulp still found considerable use in certain types of paper, but production was small compared to that of sulphite pulp. In comparatively recent years it has been found that many hardwood species pulped by the kraft process yield a bleached product of much greater strength than soda pulp produced from the same species. As a result of this development there is presently an increasing use of the hardwoods for the manufacture of bleached kraft especially suited in mixtures with coniferous pulps for a wide variety of papers. Prehydrolyzed

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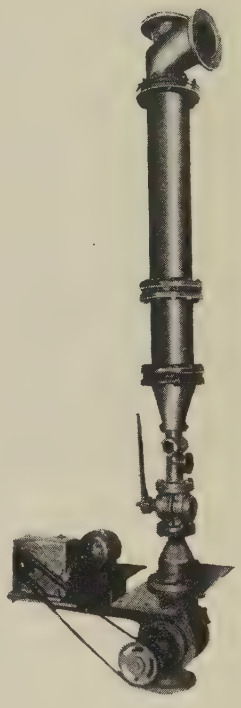

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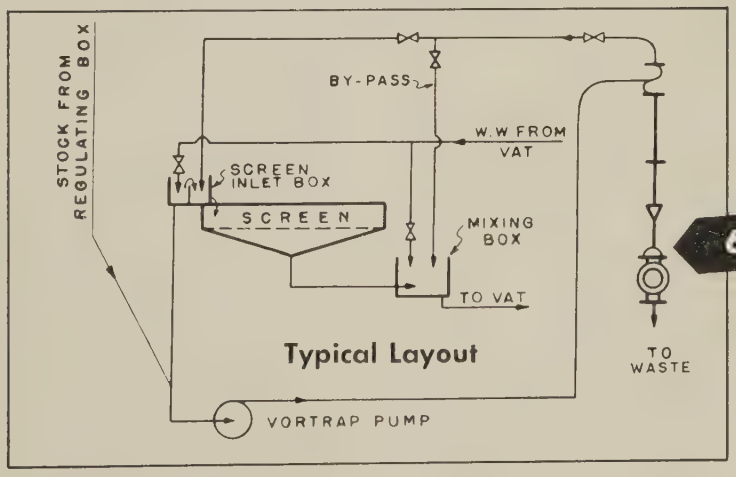

Typical Layout

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hardwood sulphate pulps have been found to be suitable for dissolving purposes both abroad and in this country.

The increasing use of hardwoods for the manufacture of sulphate pulp offers a large source of raw material for the industry.

The intelligent use of our land areas demands the cooperation of the trained forester and the agriculturist. Our growing population demands more food. Areas best suited for the growth of annual food crops and those best suited for grazing must be preserved. There are, however, cut-over forests on which farming has been attempted but which are poorly suited for this purpose. These areas should be re-

Robert B. Wolf, consultant for paper industry (left) presents TAPPI Medal to Raymond S. Hatch, Hudson Pulp & Paper Co.

turned to the production of trees to supply our growing demand for wood products. Where climate and soil now support good forest growth we should be able as time goes on to develop even greater yields through the use of proper nutrients and through the proper selection of hardy and rapid growing strains, just as the farmer of today adds to the soil chemical foods which the crop takes away from the soil as it is harvested. We can even, through proper selection, produce high yield hybrids as has been demonstrated in the case of hybrid poplars. We must employ all of these devices if we are to be assured the raw material for our increasing consumption of cellulose.

There is not much to be said about chemical raw materials. We are now witnessing a shortage of native sulphur. This is not a renewable raw material but sulphur, fortunately, is plentiful in other forms, not as easily available as native sulphur but still in ample supply for future expansion. Furthermore, much of the sulphur used in our pulping processes may be recovered if proper chemical engineering methods are used.

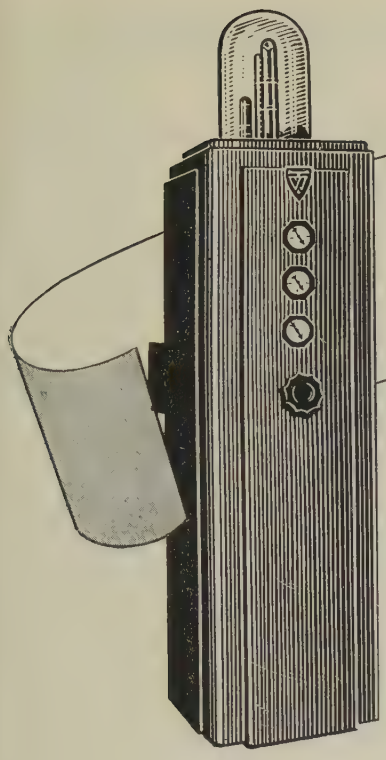
The raw material which is as important as cellulose is energy. We all know that all of our terrestrial energy comes from the sun. The energy which industry uses almost universally is fossil energy either in the form of coal, oil, or natural gas. One type of renewable solar energy is water power but as you know that is limited by rainfall and geography.

Fossil energy is limited because it is not renewable. We have coal, oil, and gas reserves which will last us for many years but increasing transportation costs of these energy sources to the forest areas where the mills are located make it desirable to turn to renewable energy sources close at hand. Because of its relatively high cost, the kraft industry was compelled to recover the soda it uses by evaporating and burning the waste liquor. The organic material from the wood and representing better than half of the wood substance is renewable energy and is now a major source of heat and power in the kraft process. The sulphite process also dissolves organic material from the wood. This is again a renewable source of energy and today there is increasing use of evaporated sulphite waste liquor as a source of energy.

The total pulp production in the United States in 1950 amounted to about 14.8 million tons. This means that the organic material dissolved from the wood in the pulping processes exceeded 15 million tons. Many uses have been suggested for this waste organic material but so far all uses combined are exceedingly small compared to the total available. For the present the best use would seem to be as a renewable source of energy, just as only a few years ago petroleum products were chiefly a source of energy. Modern chemical methods have added a new name to the petroleum industry, this is the petrochemical industry. Petroleum is being converted in ever increasing amounts into both new and old chemical compounds having much greater value than the petroleum raw material as a source of energy. The time may come when we will have a "ligno-chemical" industry. We have millions of tons of organic material available, in the form of noncellulosic material dissolved from wood. Unlike petroleum, this material is in aqueous solution. If it is to be used as fuel the bulk of the water must be removed at the expense of energy. The difference between the energy consumed in the concentration of waste liquor and the energy obtained from the combustion of the concentrated liquor represents the net energy available from a renewable source of captured solar energy. The cost of this net available energy when compared with the delivered cost of fossil energy or water power shows a favorable balance at present and this balance will be greater as fuel costs and transportation costs increase. A further advantage, of course, is the recovery of cooking chemicals either in the form of ash or smelt from the recovery furnace or from the combustion gases.

Waste liquors from the sulphite process are made up mainly of lignin sulphonic acid, some polysaccharides, simple hexose sugars, pentose sugars, and small amounts of other organic compounds. The hexose sugars may be fermented to produce ethyl alcohol, a large part of the pentose and hexose sugars may be utilized for the growing of food yeast as is now being done in Wisconsin. The market for compounds of lignin sulphonic acid is, however, limited and no large scale outlet has been found except as fuel. All of the organic solids in sulphite waste liquor are made up of carbon, hydrogen, and oxygen. They differ from petroleum compounds, which are mainly hydrocarbons having a wide boiling range but all capable of separation by distillation. Lignin compounds do not distill but suffer pyrolytic breakdowns when heated. Hydrogenation of lignin compounds so far investigated has yielded products of little commercial value but methods may be eventually developed which will yield valuable products. We know that one of the building stones of the lignin molecule is a phenyl-propane unit but we have yet to find methods which will break down the complex lignin molecule into useful relatively cheap organic products.

The waste liquor from the sulphate process is made up of thiolignin, alkali, lignin, saccharic acids, fatty acid soaps, sterols, and small amounts of resin compounds. Resinous woods such as the southern pines, when cooked by the kraft process, yield a considerable amount of what is known as sulphate soap. This is a complex mixture of the sodium salts of unsaturated fatty acids, resin acids, sterols, and unsaponifiable matter. This soap is salted out of the black liquor as it is concentrated in the evaporators and rises to the top of the partially evaporated liquor where it is separated by skimming. This sulphate soap is the raw material for the production of tall oil which is formed by acidification of the soap with sulphuric acid or nitre cake. As an article of commerce, both sulphate soap and tall oil are of more value than fuel so it is



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L. K. Burnett, Ohio Boxboard Co.

G. A. Day, Brown Corp.

customary to separate the soap and sell it as such or convert it into tall oil with simultaneous recovery of sodium sulphate. The black liquor from which the sulphate soap is separated is evaporated further and burned in the recovery furnace.

As is the case with the solids from sulphite waste liquor the sulphate residues, free from soap, still await a process which is capable of breaking them down into simpler products having values greater than their value as fuel.

It is still necessary to recover as much of the soda and sulphur as possible and up until now the recovery of these chemical raw materials is best accomplished by utilizing sulphate waste liquor as fuel.

The problem facing the research men of our industry is indeed challenging. We are fortunate in having a renewable source of energy in the waste material from the pulping of wood. This gives us the opportunity to continue our search for processes which may eventually be the foundation of a new and profitable wood chemical industry.

Report of the Tellers Committee

Simon Posen of the Gilman Paper Co. and Chairman of the Tellers Committee reported on the results of the mail ballot for election of Association Officers and Executive Committeemen. His associates on the committee were J. C. Barthel of the American Cyanamid Co. and L. G. Durant of Pandia, Inc., all of New York City. The committee reported as follows:

We the members of the Tellers Committee, having made a canvass of the official ballot for officers and members of the Executive Committee for 1952 of the Technical Association of the Pulp and Paper Industry, have found that the following have received a majority of the 1043 votes cast.

President: Kenneth P. Geohegan, Howard Paper Mills, Inc., Dayton, Ohio.
Vice-President: George H. Pringle, Mead Corp., Chillicothe, Ohio.
Executive Committeemen (to serve three years):
Lewis K. Burnett, Ohio Boxboard Co., Rittman, Ohio.
George A. Day, Brown Co., Berlin, N. H.
Harry F. Lewis, Institute of Paper Chemistry, Appleton, Wis.
James R. Lientz, Union Bag & Paper Corp., Savannah, Ga.

TAPPI 1952 Executive Committee

As reported by the Tellers Committee, Kenneth P. Geohegan and George H. Pringle were elected President and Vice-President, respectively, of the Technical Association.

Members of the committee whose terms continue are Milton Jacobs, Chas. T. Main, Inc., Boston, Mass.; R. W. Kumler, American Cyanamid Co., New York, N. Y.; K. O. Elderkin, Crossett Paper Mills, Crossett, Ark.; G. E. Shipman, Donnacona Paper Mills, Ltd., Donnacona, Que., Canada; W. D. Harrison, Riegel Paper Corp., Milford, N. J.; W. F. Hathaway, Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.; W. A. Holzer, Crown Zellerbach Corp., Camas, Wash.; and R. P. Price, Hammermill Paper Co., Erie, Pa.

The members whose terms expired in February, 1952, were James d'A. Clark, Consultant, Longview, Wash.; M. L. Downs, Thilmany Pulp & Paper Co., Kaukauna, Wis.; and Werner Kaufmann, retired, Great Neck, N. Y. James R. Lientz, whose term expired, was re-elected to a three-year term, having completed a one-year term.

Following are brief biographies of the individuals elected to serve the Association for the coming year. (Biographies of K. P. Geohegan, G. H. Pringle, and J. R. Lientz appeared in the March, 1951, issue of *Tappi*.)

Lewis K. Burnett, Manager of Quality Control for the Ohio Boxboard Co., Rittman, Ohio, was born in Hartford, Conn., in 1907 and graduated from the New York State College of Forestry, Syracuse, N. Y., in 1935. Prior to joining the Ohio Boxboard Co., Mr. Burnett was employed by the Robert Gair Co. in Peirmont, N. Y., and New London, Conn., and the Curtis Publishing Co. in Philadelphia. In TAPPI he was one of the organizers of the Lake Erie Section and its first chairman, prior to the granting of the Section Charter. He is, at present, Secretary of the Corrugated Containers Committee and has done much to advance the work of this new and important committee.

George A. Day is Chief Chemist for the Brown Co., Berlin, N. H. He was born at Guelph, Ont., in 1901 and graduated from the University of Toronto. From 1922 to 1926 he was Manager of Industrial Laboratories Ltd. in Toronto and joined the Brown Co. in 1926, first being employed at its La Tuque, Que., mill. He is Chairman of the Maine-New Hampshire Section.

Harry F. Lewis, Professor of Organic Chemistry and Dean of Students of The Institute of Paper Chemistry, Appleton, Wis., was born in Denver, Colo., in 1891. He graduated from Wesleyan University and received his doctorate in 1916 from the University of Illinois. In 1918–19 he was Associate Professor of Organic Chemistry at the University of Maine. From 1919 to 1921 he was a Research Chemist for the National Aniline Co. at Buffalo. From 1921 to 1928 and 1928 to 1930 he was Professor of Chemistry at Cornell College and Ohio Wesleyan University, respectively. In 1930 he joined Otto Kress as a pioneer of the staff of The Institute of Paper Chemistry at Appleton, Wis. From here on this biography could become lengthy but sufficient to say that as Chairman of the TAPPI Fundamental Research Committee he has done much, through its famous conferences, to enrich the literature of the industry with scientific publications.

Research Appropriations Committee

During 1951 ten requests for research funds were approved by the Research Appropriations Committee, and one request

H. F. Lewis, The Institute of Paper Chemistry

J. R. Lientz, Union Bag & Paper Corp.

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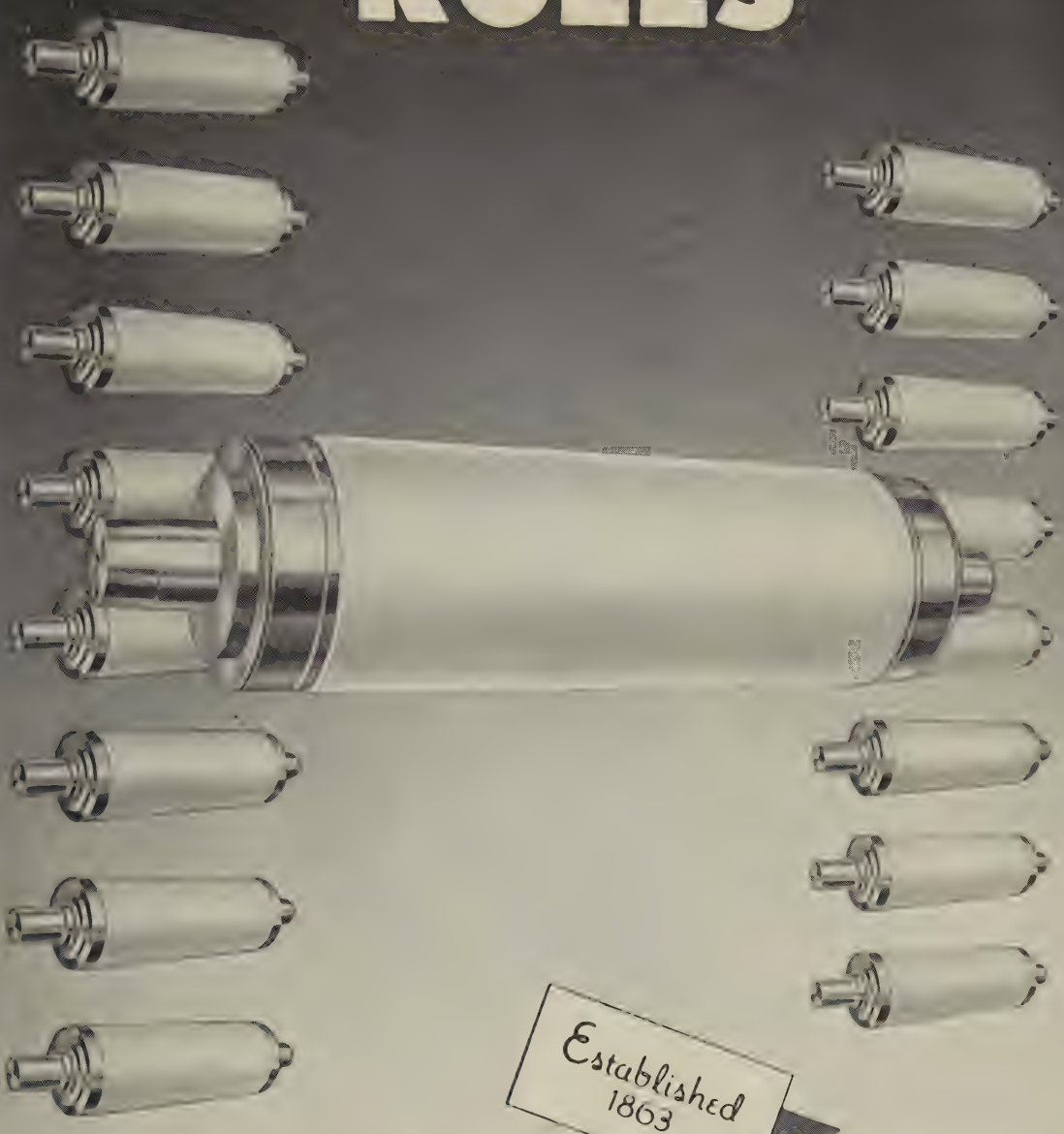

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(No. 34) was not approved by a majority of the Committee. The requests are summarized in the following table.

Request no.	Project	Committee	Amount
26	Cellulose Viscosity Methods	Chemical Methods	$ 1,200
27	Friction of Stock in Pipes	Hydraulics	2,500
28	Properties of Ammonium and Magnesium Bisulphite Solutions	Acid Pulping	2,000
29	Construction and Testing of Freeness Testers	Structural Fibrous Materials	1,000
30	Sugars in Insoluble Residue from Pulp Fibers	Fundamental Research	2,000
31	Dye Adsorption on Wood Pulp Fibers	Fundamental Research	3,500
32	Rate of Loading in Flexural Resistance and Deflection of Fiberboard Test	Structural Fibrous Materials	1,000
33	Racking Strength Test for Insulating Board	Structural Fibrous Materials	2,500
34	Agricultural Residues Pulps	Fibrous Agricultural Residues	Not granted
35	Test Board Forming Machine for Insulating Board	Structural Fibrous Materials	3,946
36	Corrosion of Digesters in Kraft Mills	Chemical Engineering	4,000
			$23,646

Progress or final reports on many of these projects will be presented at the 1952 Annual TAPPI Meeting.

The Executive Committee appropriated $60,000 for research grants during 1951. The sum expended amounted to $23,646, leaving a balance of $36,354.

There has been a significant increase in the committee requests for financial assistance during 1951, but these requests came from only seven committees, which is less than 20% of the major committees listed in the Year Book, not including the subcommittees. The recently issued APPA report on "Technical Problems in the Pulp and Paper Industry" should be brought to the attention of every Division chairman and every committee chairman for the many suggestions it contains on important research problems vital to our industry. This publication should prove to be an excellent source of project material for committee activities. We hope arrangements can be concluded for reprinting this report in an early issue of *Tappi*.

The Research Appropriations Committee was reorganized in 1951 and its personnel now comprises ten people and a chairman, all of whom have had considerable experience with the affairs of the Association over a period of several years. The committee is charged with the responsibility of administering the sum of money appropriated each year by the Executive Committee for assisting the activities of the committees of the Association. If the approval of a request for a research grant is unanimous on the part of the Research Appropriations Committee, the grant is made. If there is only a majority approval, the decision is made by the Executive Committee. Majority disapproval of a request constitutes its rejection.

Policies relating to the procedure to be followed in submitting a request for a research grant are as follows:

1. All requests for research grants or financial aid for Association projects shall initiate within the committee organization. Research grants are to be considered only for committee-sponsored projects. In general, the request for aid should be approved by a majority vote of the sponsoring committee.

2. The application for financial aid should be sent by the committee chairman to the respective division general chairman for his approval and transmittal to the chairman of the Research Appropriations Committee.

3. The information to be supplied to the division general chairman and the Research Appropriations Committee should be grouped under the headings found on page 48 of the 1951 TAPPI Year Book relating to "Regulations Governing Research Appropriations."

The present members of the Research Appropriations Committee are:

K. P. Geohegan
G. H. Pringle
Allen Abrams
A. E. Bachmann
H. W. Bialkowsky
W. F. Gillespie
J. W. Hemphill
J. D. Malcolmson
A. L. Sherwood
W. H. Swanson

John L. Parsons, *Chairman*
Research Appropriations Committee

Report of the Joint Textbook Committee

The Joint Textbook Committee of the Paper Industry consists of H. S. Spencer, Chairman, R. S. Hatch, Douglas Jones, R. G. Macdonald, and R. S. Kellogg, Secretary. J. N. Stephenson is Editor.

The activities of the committee during 1951 are summarized as follows:

Finances

Receipts:		
Cash on hand Jan. 1, 1951	$3289.12	
Bonds sold	488.56	
Royalties during year 1951	685.08	
Interest on securities	12.50	
		$4475.26
Expenses:		
Salary (Editor)	$1700.00	
Textbook Revisions	2204.26	
Miscellaneous (postage, supplies, bank, commissions, etc.)	150.07	
		$4054.33
Assets Jan. 1, 1952:	$ 420.93	
Cash		$ 420.93

Sales of textbooks in 1951 totaled 4175 volumes of which 2284 and 1198 represented sales of Volumes I and II, respectively, of the revised edition. Various volumes of the preceding edition, totaling 693, were also sold.

Total sales of 4175 in 1951 compared with 2621 in 1950: 1471 in 1949; 1366 in 1948; 3377 in 1947; 2209 in 1946; 1239 in 1945; 1014 in 1944; 871 in 1943; and, with 790 in 1942.

	1951 sales	*Total to date*
Volume I	27	6,297
Volume II	..	5,511
Volume III	3	15,339
Volume IV	425	12,675
Volume V	238	11,276
Total (preceding three editions)	693	51,098
Volume I (Fourth edition)	2284	4119
Volume II (Fourth edition)	1198	1198
Total	3482	5317

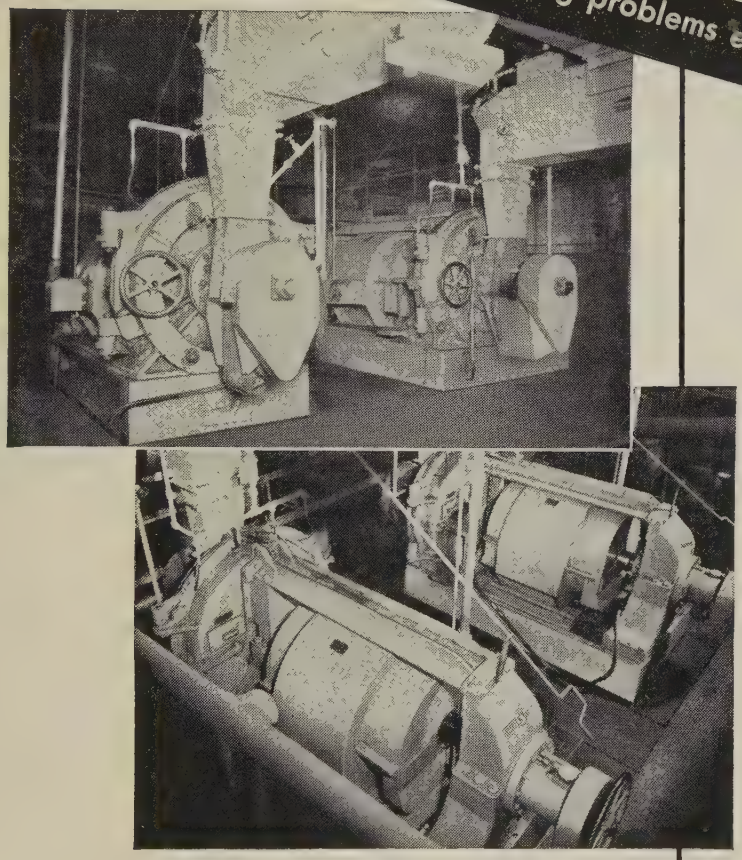
Grand total sales of all volumes and all editions since first publication in 1921 is 56,415 copies.

The rapidity with which the new volumes are being eagerly bought by the world-wide pulp and paper industry is conclusive testimony to their value. It is especially notable that Volume II, coming out the last week in October, had sales of 1198 copies in slightly more than two months. The final chapter in this volume—upon semichemical and other special processes—was added after the other chapters were completed. This was made possible through the fine cooperation of the United States Forest Products Laboratory, The In-

PINPOINT

your pulp quality requirements with a Sprout-Waldron refiner

FIR-TEX INSULATING BOARD CO. CHOOSES SPROUT-WALDRON'S to solve refining problems economically!



Two Sprout-Waldron 36-2 Refiners prepare pulp from steamed chips for the well-known "FIR-TEX" INSULATING BOARD.

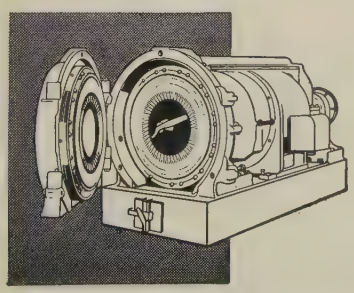
- High pulp quality
- High capacity
- Flexibility of operation
- Rugged construction
- Low maintenance

Are you on our **BETTER FIBERS mailing list?**

This Sprout-Waldron technical publication reports important information on new and improved pulping processes—including semichemical pulping.

We will gladly send you copies regularly. Write Sprout-Waldron & Company, Inc. 38 Logan Street, Muncy, Pennsylvania.

S W



SPROUT-WALDRON

PULP REFINERS

194

A Sight-Flow Indicator
that Really Works

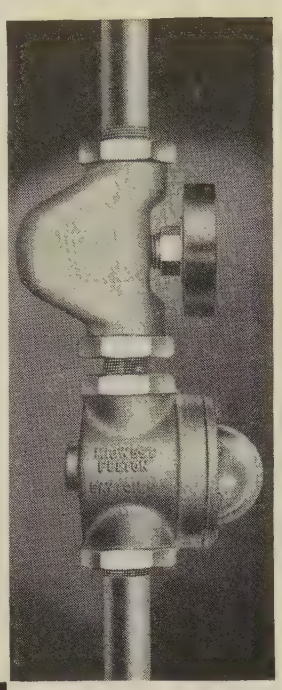
The Midwest Ball Sight-Flow is the one and only dryer condensate indicator with a "Window" that really stays clear—is constantly being scoured and kept clean by the violence of the liquid as it passes. The thousands already in use on both wet and dry end dryers prove that statement.

Flow visible from front and both sides. Installation in discharge line either vertical or horizontal.

Equip your dryers, particularly the wet end section, and keep tab on condensate flow. Add Midwest non-corrosive temperature indicator to help you spot subnormal temperatures.

Sight-Flow fitting all bronze and non-corroding. Glass ball of heavy Pyrex glass and replaceable. Assembly effective for steam pressures up to 75#. Standard pipe sizes ½", ¾", 1", 1¼", 1½". Temperature indicator also non-corroding.

Order several now and you'll order more later. They do the work or we take them back.



Midwest-Fulton Machine Company **Dayton • Ohio**

stitute of Paper Chemistry, the New York State College of Forestry at Syracuse, and the McGraw-Hill Book Co.

The editor celebrated New Year's eve last by getting the manuscript and illustrations for Volume III to the publisher an hour before midnight so that he might wind up 1951 with a clear conscience. This volume deals with the Manufacture and Testing of Paper and Board and should be available before the end of 1952.

Work on Volume IV—the last and final of the new series—is well along and its publication in 1953 will fittingly coincide with the 35th anniversary of the setting up of this committee to do a specific job for the industry.

ROYAL S. KELLOGG, *Secretary*

British Paper and Board Makers Meeting

The Technical Section of the British Paper and Board Makers Association will hold its 63rd General Conference on March 27–28, 1952, at Mauson House, Portland Place, London, W.1., England.

The official dinner will be held at the Trocadero Restaurant, London, on March 27. Six papers will be presented dealing with the problem of European supplies of fibrous papermaking materials. Members of TAPPI have been cordially welcome to attend by the Executive Committee of the Section.

Paper and Paperboard Monograph

The American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., has issued a revised edition of its 1944 monograph on Paper and Paperboard—Characteristics, Nomenclature, and Significance of Tests. This publication is sponsored by A.S.T.M. Committee D-6 on Paper and Paper Products. Copies may be obtained from the A.S.T.M. at $2.50 per copy.

HERMANN *Improved* CLAFLIN

"IN THE PULP MILL"

BROWN STOCK: Defibering and Breaking up Knots. Up to 500 tons per day. 200–300 HP.

DEFIBERING and PREREFINING: Ahead of Washers. No cutting or reduction of Freeness. Operated under pressure. Does not handicap or retard washing. Four No. 3 Claflins required for up to 600 tons per day. Knotters not required. Stock Flow: BLOW TANK—MAGNETIC SEPARATOR—PUMP—MAGNETIC SEPARATOR—CLAFLIN—WASHERS.

DEFIBERING: Ahead of bleaching. Kraft, Sulphite and Soda pulps. Deinked Stock.

PREBEATING: Washed pulps before going to the Paper Mill.

KNOTTER and SCREEN REJECTS: Kraft and Sulphite. Closed or continuous systems.

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PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Henry E. Arkens, Technical Sales, Ansul Chemical Co., Marinette, Wis., a 1948 graduate of the University of Michigan.

Roland E. Boedeker, Supervisor, Technical Work, Container Corp. of American, Los Angeles, Calif., a 1946 graduate of Iowa State College.

Ronald O. Brabon, Research Chemist, Reichhold Chemicals, Inc., Detroit, Mich., a 1938 graduate of Hillsdale College.

Paul U. Bretschger, Chemist, Buffalo Electro-Chemical Co., Inc, Buffalo, N. Y. a 1949 graduate of Cornell University.

Raymond W. Brown, Partner, The Brown-Singer Co., Middletown, Ohio, a 1942 graduate of Purdue University.

Donald A. Burris, Manager, Pulp and Paper Div., Canadian Ingersoll-Rand Co. Ltd., Montreal, P. Q., Canada, a 1945 graduate of Nova Scotia Technical College.

Dan B. Chapman, Sales Engineer, Morden Machines Co., Portland 4, Ore., a 1933 graduate of Los Angles City College.

Lee Kwai Cheuk, Assistant Manager, Kung Lee Hong, Hong Kong, China, a 1929 graduate of Lingnan University.

Gordon E. Cole, Technical Sales, Air Reduction Sales Co., New York, N. Y., a 1943 graduate of Amherst College.

Derek G. Currie, Manager of Manufacturing, The E. B. Eddy Co., Hull, P. Q., Canada, a 1935 graduate of Christ's Hospital College.

Arthur H. Damon, Engineer, Newsprint Service Bureau, New York, N. Y., a 1951 graduate of New York State College of Forestry.

Ralph R. David, Associate Editor, *Pulp & Paper,* Miller Freeman Publications, New York, N. Y., a 1932 graduate of the University of Oregon.

George F. Davidson, Principal Research Officer, Cellulose Chemistry, British Cotton Industry Research Association, Didsbury, Manchester, England, a 1921 graduate of Edinburgh University.

Henry H. Derr, Plant Engineer, Marinette Paper Co., South Glens Falls, N. Y., a 1939 graduate of Haverford College.

Stanislaw Dominik, Chemical Engineer, Irving Pulp & Paper Ltd., Fairville, N. B., Canada, a 1951 graduate of the University of Toronto.

John F. Donahue, Jr., Student, University of Maine, Orono, Me., a 1948 graduate of Brown University.

Donald P. Finnegan, Student, New York State College of Forestry, Syracuse, N. Y.

Joseph Gessner, Head of Paper Div., E. I. du Pont de Nemours & Co, Inc., Technical Laboratory, Wilmington, Del., a 1932 graduate of Temple University.

Edward L. Hamilton, Jr., Chemist, St. Regis Paper Co., Deferiet, N. Y. a 1948 graduate of the University of Maine.

Jerome P. Hendel, Technical and Sales Representative, O. L. West, Philadelphia, Pa., a 1947 graduate of the University of Notre Dame.

Cecil L. Hess, Electronic Technician, Second Class Petty Officer, U. S. Navy, a 1951 graduate of The Institute of Paper Chemistry with a Ph.D. degree.

George H. Hocking, Sales Engineer, Socony-Vacuum Oil Co., Albany, N. Y., a 1942 graduate of Pennsylvania State College.

William I. Hodge, Manager, Pacific Coast Engineering Div., Bulkley, Dunton Pulp Co., Pasadena, Calif. Attended Columbia College.

Carl F. Hoelderle, District Manager, Anheuser-Busch, Inc., Kalamazoo, Mich.

Alexander E. Hutton, Jr., Research Chemist, Westfield River Paper Co., Russell, Mass., a 1950 graduate of American International College.

Robert H. Jensen, Chief Engineer, Rhinelander Paper Co., Rhinelander, Wis.

Wilfred E. Johnson, Chemical Engineer, Union Bag & Paper Corp., Savannah, Ga., a 1951 graduate of Worchester Polytechnic Institute.

Frederick W. Kressman, Jr., Vice-President, Continental Turpentine & Rosin Corp., Laurel, Miss., a 1934 graduate of Massachusetts Institute of Technology.

Stig Lagergren, Control Engineer, U. S. Gypsum Co., Clark, N. J., a 1944 graduate of the State College of Harnosand, Sweden.

Elmo H. Madison, Research Chemist, Minnesota & Ontario Paper Co., International Falls, Minn., a 1937 graduate of the University of Minnesota.

John R. Mazeau, Field Service Engineer, National Starch Products, Inc., New York, N. Y., a 1949 graduate of the University of New Hampshire.

Orla L. McCormick, Technical Director, Shawano Paper Mills, Shawano, Wis. Attended Kansas State College.

Donald P. McNelly, Quality Control Engineer, Fort Wayne Corrugated Paper Co., Hartford City, Ind., a 1942 graduate of General Motors Institute.

Bernard L. Merriss, Plant Engineer, Oxford Miami Paper Co., West Carrollton, Ohio, a 1938 graduate of the University of Kentucky.

Otto M. Miller, Assistant to Plant Manager, American Coating Mills, Div. of Owens-Illinois Glass Co., Elkhart, Ind.

Victor G. Morgan, Head of Paper Technology Laboratory, Imperial Chemical Industries Ltd., Dystuffs Div., Blackley, Manchester, England, a 1933 graduate of London University.

Robert W. Mortensen, Chief Engineer, Wausau Paper Mills Co., Brokaw, Wis., a 1936 graduate of the University of Wisconsin.

Adam V. Pollak, Assistant Sulphite Superintendent, Minnesota & Ontario Paper Co., International Falls, Minn., a 1937 graduate of the New York State College of Forestry.

Dennis S. Reidy, Sr., Superintendent, Robert Gair Co., Inc., Ohio Corrugated Box Div., Cleveland, Ohio.

Robert Remy, Technical Service, Achard-Picard, Remy & Co., Paris, France

Howard S. Rish, Plant Manager, American Coating Mills, Div. of Owens-Illinois Glass Co., Elkhart, Ind., a 1920 graduate of Purdue University.

Georges Robin, Engineer, Societe Lumiere, Lyon, France. Attended the Technical College, Lyon.

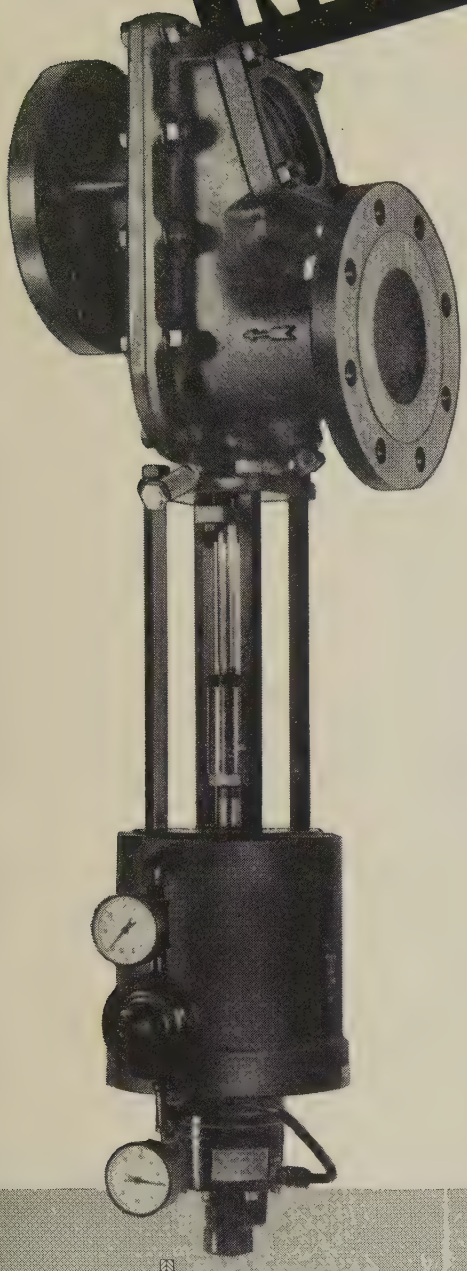
Reid Sprague, Jr., Organic Chemist, Detroit Testing Laboratory, Inc., Detroit, Mich., a 1948 graduate of Hillsdale College.

Conrad Steen, Superintendent, Paper Mill, Hunsfos Fabrikker, Vikeland, near Kristiansand S., Norway. Attended Gothenburg Technical College.

NEW

F & P RATOGATE SLURRY FLOW CONTROL VALVES

- *Wide-Range*
- *Self-Cleaning*
- *Non-Plugging**
- *Minimum Friction*



Entirely original, revolutionary in design, these new F&P pulp and paper stock valves create pronounced, visible turbulence in the inlet area, yet discharge a smooth, even flow. Stock simply cannot collect to cause plugging even at extremely low flow rates. Lack of the usual gate or plug guides minimizes friction, makes sensitive flow control possible over the entire wide-range of operation.

A RATOGATE Valve plus the well-known F&P RATOSLEEVE flow meter and RATOMATIC flow controller make up a complete, positive, and precise automatic flow control system for proportioning slush stocks and for liquid level control.

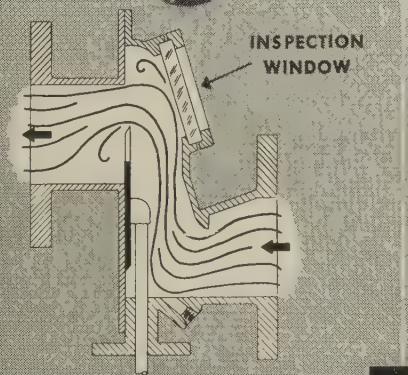
Applications include flow control of lime, starch, and carbonate slurries, automatic proportioning and level control systems for handling pulp or paper stocks and similar slurries for pulp fiber recovery systems.

Stainless steel is the standard material of construction. Other materials are available. Valves have polished stainless steel stems and sliding gates. Connections are 150# standard ASA flanges.

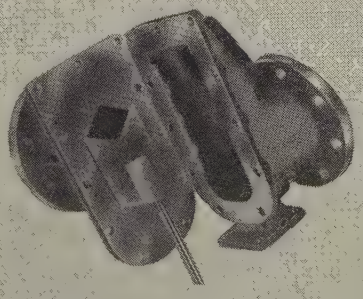
*HERE'S THE REASON . . .
there's no plugging in RATOGATE valves

This line is the actual size and shape of the outlet port of "through-flow" slurry control valve if it were passing 30 GPM of 4% A.D. pulp.

Here is the outlet port of the new 4" RATOGATE Valve which controls less than 30 GPM of 4% A.D. stock without plugging. The diamond shaped port is superior because it offers a minimum perimeter for the area of opening.



CROSS SECTION OF RATOGATE VALVE SHOWING FLOW LINES WHEN GATE IS LESS THAN HALF OPEN.



DIAMOND SHAPE PORT PROVIDES MINIMUM PERIMETER FOR OPENING AREA.

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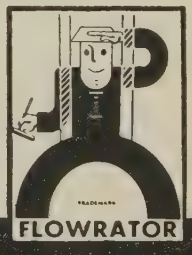
PROCESS CONTROL INSTRUMENTS



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SALES ENGINEERING OFFICES THROUGHOUT THE WORLD

Chester N. Stupp, Assistant Manager, Sales Service, Oxford Paper Co., New York, N. Y. Attended Manchester College.

Stanley M. Suchecki, Technical Representative, American Aniline Products, New York, N. Y., a 1947 graduate of Philadelphia Textile Institute.

Frank A. Turner, Sales Engineer, Morden Machines Co., Portland, Ore., a 1943 graduate of Oregon State College.

Thomas A. Watchorn, Control Engineer, Abitibi Power & Paper Co., Sturgeon Falls, Ont., Canada, a 1950 graduate of Queen's University.

J. Lloyd Weaver, Plant Manager, The Fairbanks Fibre Box Co., Middletown, Ohio, a 1923 graduate of Franklin and Marshall College.

Walter D. Willetts, Service Engineer, Albany Felt Co., Albany, N. Y., a 1949 graduate of the New York State College of Forestry.

Albert L. Wiley, Technical Director, Riegel Carolina Corp., Acme, N. C., a 1943 graduate of North Carolina State College.

William B. Wilson, Applications Engineer, Industrial Power Div., General Electric Co., Schenectady, N. Y., a 1940 graduate of the University of Tennessee.

Alan J. Woodfield, Industrial Engineer and Personnel Relations Supervisor, Continental Paper Co., Ridgefield Park, N. J. Attended New York University.

Donald A. Yateman, Student, New York State College of Forestry, Syracuse, N. Y.

TAPPI Notes

Wm. H. Aiken, formerly of the Goodyear Tire & Rubber Co., is now with Gardner Board & Carton Co., Middletown, Ohio.

J. C. Barthel of the American Cyanamid Co. is now with the New Products Development Section, Paper Chemicals Dept., New York, N. Y.

Clyde A. Benson, formerly associated with Arno W. Nickerson, is now established as a Consultant in Paper Making and Converting at Nyack, N. Y.

Robert G. Betts is now Excutive Vice-President and Treasurer of W. & L. E. Gurley, Troy, N. Y.

Carl L. Brickman, formerly of Benj. C. Betner Co., is now Chemist for the Arvey Corp., Jersey City N. J.

E. W. Bryan, formerly of J. E. Sirrine Co., is now with Bryan Associates (Engineers and Consultants), Box 442, Charlotte, N. C.

Ian M. Chandler, formerly of St. John Sulphite Ltd., is now Chemical Engineer, Brown Corp., La Tuque, Que.

Harry K, Collinge, formerly of the Canada Paper Co., is now Technical Specialist for the Howard Smith Paper Mill Ltd., Montreal, Que.

Joseph P. Corbin, formerly of the American Cyanamid Co., is now Chemist for the Great Northern Paper Co., Millinocket, Me.

Clyde E. Cromwell is now Sales Manager, Commercial Div., De Laval Steam Turbine Co., Trenton, N. J.

Robson B. Dunwody, formerly of the Celotex Corp., is now with Dunwody Engineering Co., 205 W. Wacker Drive, Chicage. Ill.

Edson J. Ferrell, formerly of the Fraser Paper Co., is now Chemist for Crocker, Burbank & Co., Fitchburg, Mass.

R. G. Goodwin is now Director of Sales Engineering, Pandia, Inc., New York, N. Y.

Allen H. Gridley, formerly with H. K. Ferguson Co., is now Engineer for the National Container Corp., Jacksonville, Fla.

Paul W. Hardesty of the Mead Corp. has transferred from from Nashville, Tenn., to Wheelwright, Mass.

Charles Kelley, Jr., formerly of H. & T. McClusky & Sons Co., Inc., is now with H. Waterbury & Sons Co., Oriskany, N. Y.

John R. Lavigne, formerly of the West Virginia Pulp & Paper Co., is now Assistant Sales Manager, Mechanical Products Div., The Foxboro Co., Foxboro, Mass.

Harry K. Linzell, formerly of the U. S. Wallboard Machinery Co., is now Vice-President in Charge of Engineering for the Tayler Corp., New York, N. Y.

H. A. Lips is now in the Organic Chemicals Dept., Dyestuffs Div., E. I. du Pont de Nemours & Co., Wilmington, Del.

Donald G. Magill, formerly with the Riegel Paper Corp., is now Lt. (j.g.) Assistant Engineer, U. S. Navy, U.S.S. *Cotten,* F.P.O., New York, N. Y.

Manuel C. McDonald, formerly of Chesapeake Corp. of Va., is now President of the Great Northern Paper Co., Bangor, Me.

E. David McKay, formerly Technical Assistant at The Institute of Paper Chemistry, is now in the Research & Development Dept., Southern Chemical Cotton Co., Chattanooga, Tenn.

Robert W. Miller, formerly of the Masonite Corp., is now Chemical Engineer for The Pacific Lumber Co., Scotia, Calif.

Clinton A. Mohler of The Foxboro Co. has transferred from Troy, Ohio, to Decatur, Ala.

Thomas J. Muldoon, formerly of General Food's Central Research Laboratory, is now Consultant for the Fibre Box Association, Washington, D. C.

Bengt Niberger, formerly of Spencer, Lock & Co., Ltd., London, England, is now Assistant to the President and Sales Manager of Berndt Nyvall A/B, Kristinehamn, Sweden.

Sture G. Olsson, formerly Plant Engineer, is now Executive Vice-President of the Chesapeake Corp. of Va., West Point, Va.

F. W. O'Neil is now Professor of Pulp and Paper Manufacture, College of Forestry, State University of New York, Syracuse, N. Y.

Lester H. Peterson, formerly of the Consolidated Machine Tool Co., is now Plant Chemist for the Rising Paper Co., Housatonic, Mass.

Alexander J. Philip is now Assistant General Manager of the Canada Paper Co., Windsor Mills, Quebec.

Erving W. Rasmussen, formerly of the Marinette Paper Co., is now Tissue Coordinator for the Scott Paper Co., Chester, Pa.

S. A. Salmonson, formerly Pacific Coast Representative for Chemical Linings, Inc., Homad Services Ltd., and Nukun Products Corp., is now a Consultant in Portland, Ore.

James R. Schoettler, formerly of the Kimberly-Clark Corp., is now with the U. S. Marine Corps, Quantico, Va. (Mail address: 12 West Court, Appleton, Wis.)

Norman G. Sixt, formerly of the Carborundum Co., is now Technical Sales Engineer for the Rodney Hurt Machine Co., Orange, Mass.

C. W. Smith, formerly President of the Central Paper Co., is now Secretary-Treasurer and Consulting Engineer for Sales and General Development Associates, Inc., North Muskegon, Mich.

Herbert A. Smith is now Assistant Technical Director for the Mead Corp., Chillicothe, Ohio.

Sam S. Stevens, Consultant to Pulp and Paper Mills, has transferred his offices from Plattsburg, N. Y., to Troy, N. Y.

William A. Stone, Chemical Engineer for the Mathieson Chemical Co., has transferred from Nigara Falls, N. Y., to New Orleans, La.

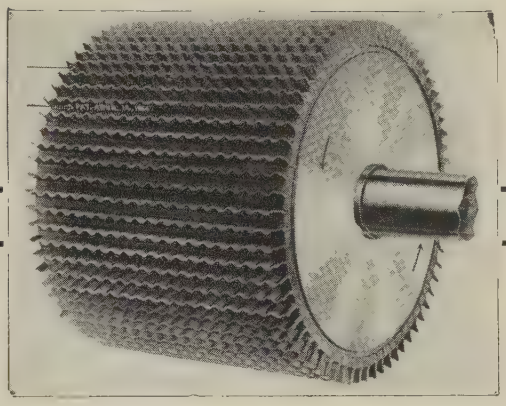
W. H. Swanson is now Assistant Vice President and Director of Research and Development for the Kimberly-Clark Corp., Neenah, Wis.

Gabriel T. Turula, formerly of the Empire Box Co., is now in the Technical Service Dept., International Div., Corn Products Refining Co., New York, N. Y.

John Van Ounsem, formerly Chemist, is now Paper Mill Manager for the Pioneer Div., The Flintkote Co., Los Angeles Calif.

To Speed Up Beater Circulation and Improve Quality of Furnish

See that our Custom-Forged bars are the long-wearing SWW QUALITY. Cutting edges straight, corrugated, or staggered . . . and are teamed with a standard or specially designed SWW Bed Plate.



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Rag Cutter Knives
Stop Cutters

SWWCo

Precision

REG. TRADE MARK

PAPER KNIVES

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DAYTON, OHIO

Victor M. Vidal is now Pulp Mill and Laboratory Superintendent for Cia. Ind. de Cetenquique, S. A., Jalisko, Mexico.

John E. Ward, formerly of P. H. Glatfelter Co., is now Research Chemist for the Nopco Chemical Co., Harrison, N. J.

* * *

Foster P. Doane, Jr., Production Manager, is now the official corporate representative in TAPPI of the Bergstrom Paper Co., Neenah, Wis., succeeding *L. A. Carpenter,* deceased.

* * *

The William Cabble Excelsior Wire Mfg. Co., Brooklyn, N. Y., has changed its name to The Cabble Wire Co., Inc.

C. C. Holland, Director of Advertising and Sales Promotion, is now the official representative of Interchemical Corp., Printing Ink Div., in the Technical Association, succeeding *George Welp,* deceased.

H. A. Raymond, Jr., Sales Manager for Industrial Resins, is now the official representative in TAPPI for the Plaskon Div., Libbey-Owens-Ford Glass Co., Toledo, Ohio, succeeding *D. B. Hatcher* who is now General Manager of the Stephen Chemical Co., Chicago, Ill.

W. O. Hisey, Vice-President, is now the official representative in TAPPI for the Sandy Hill Iron & Brass Works, Hudson Falls, N. Y., succeeding *Foster P. Doane, Jr.*, who is now with the Bergstrom Paper Co.

Industry Notes

Not counting office and woodlands employees, the pulp and paper industry now employs 210,000 men and women earning approximately 765 million dollars a year. Including office and logging employees, the total is about one half million working people.

* * *

A Belgian-American financial syndicate has been organized to erect the Belgian Congo's first paper mill. The U. S. interests are headed by Lawrence Ottinger, President of the U. S. Plywood Corp. The mill will utilize timber from extensive tracts in the Congo being cleared for cotton cultivation.

* * *

The NPA has extended to March 22, 1952, the certificate of necessity previously granted to Columbine Development Co. to build a pulp mill near Newcastle, Colo. The Columbine mill will not produce newsprint.

* * *

Celgar Development Co., an affiliate of Celanese Corp. of America, announces that it will embark on a 65 million dollar wood pulp and newsprint development in the Arrow Lakes region of southeastern British Columbia. The project calls for two and possibly four mills near Castlegar, 250 miles east of Vancouver. Present plans call for the construction of a kraft mill with a daily capacity of 400 tons of bleached and semibleached wood pulp and a groundwood mill with a daily capacity of 275 tons of newsprint.

* * *

The Office of International Trade has announced that the United States will be able to export only 465,000 tons of crude sulphur during the first half of 1952, a cut of 25,000 tons from the combined quota for the last half of 1951.

* * *

The preliminary estimate of paper and board production is 26,119,000 tons. When compared with 1950 production all grades were higher in 1951 with an over-all average increase of 7%. Considering the rate of production in the first half of 1951 it was demonstrated that the industry, under pressure, could produce at an annual rate of 27½ to 28 million tons.

* * *

French interests are planning to finance and equip a newsprint mill near Iquitos, Peru, at a cost of 4.5 million dollars. The plant is expected to satisfy the domestic demand.

* * *

The Defense Production Administration has announced that the current list of priorities for processing applications for certificates of necessity for rapid tax amortization has been expanded to include pulp, paper (especially newsprint), and paperboard.

* * *

The production of a ton of newsprint in a typical American paper mill requires from one to almost six man-hours of labor, according to a report on productivity and factory performance of pulp and paper mills released by Robert R. Behlow, Regional Director of the U. S. Department of Labor's Bureau of Labor Statistics. During this time, the incoming logs are trimmed, cut, converted into pulp, and finally into paper. These data have been compiled by the Bureau's Division of Productivity for the Technical Assistance Program of the Mutual Security Agency which is making available to cooperating European countries a series of services designed to increase the efficiency of production of industrial enterprises.

In 1947, 226 pulp mills produced 13,250,000 short tons of wood pulp valued at almost one billion dollars. Pulp is then converted to paper in over 750 paper mills. The aggregate value of the products comprising the paper and allied products industry places it among the first 10 manufacturing industries in the United States. Per capita consumption of paper and paper products, totaling approximately 390 pounds per annum, is equally divided between paper and paperboard consumption.

The products covered in this report for which production man-hour requirements are presented include newsprint; writing paper; Kraft wrapping paper; paperboard, a corrugating paper used in the manufacture of corrugated boxes; folding boxboard; and lastly, specialty papers, such as waxing and fruit wrapping papers.

One of the most important reasons for high productivity in the pulp and paper industry in the United States is the high degree of product specialization and standardization. In job order mills which make paper to customer specifications, it is customary to hold small orders until they add up to specified minimum production runs, thus avoiding frequent stoppage of machinery in order to make adjustments for product change.

The high degree of specialization facilitates the use of large, fast papermaking machines in newsprint and kraft paper mills, where the demand for the product is large and continuous. These mills are usually located near the forests from which pulpwood is obtained, and thus have some assurance of a continuous supply of raw material.

Increased productivity and reduction of worker fatigue have been attained through use of improved materials handling devices, particularly in wood handling and in those papermaking operations which are nonautomatic. In the woodyard of a pulp mill, for example, where incoming logs are trimmed, cut, debarked, and stored, several mills have speeded up production by the use of waterways to float logs from one operation to the next and also by the use of mechanical lifting and machine feeding devices. In the paper mill increased production has resulted from the use of electrically powered monorail hoists for carrying material between work stations, powered lift trucks, and the installation of automatic devices such as pressure recorders and humidity indicators.

The report is presented in three parts. Part I, which may appeal primarily to those with a broad interest in the pulp and

In The Paper Industry
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Whether *your* operations call for *electrical* recovery . . . or *mechanical* recovery . . . or *both* working in combination—Western Precipitation can design and install the type best suited to your needs—under *one* guarantee and *one* responsibility!

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paper industry, describes the outstanding characteristics of the industry in terms of the product, plant, and equipment. Important factors related to high productivity are noted.

Part II, primarily for use by production technicians, presents detailed data on the unit man-hours required in the key operations within each department. Description of the operations and types of equipment used are also included.

Part III contains several sections on pertinent facts about the industry and the individual plants studied. These sections include information on the position of the pulp and paper industry within the American economy, samples of production control forms, flow charts, and a glossary of technical terms.

The report, entitled "Pulp and Paper Mills: Case Study Data on Productivity and Factory Performance," may be obtained free from the Bureau's Regional Office.

* * *

The pulp and paper industry in Canada is first in employment, total wages paid, export values, and capital investment. The output of all grades of pulp and paper reached a record high of 9,600,000 tons in 1951, an increase of 8–9%. The gross value was about $1,200,000,000.

* * *

The following data show the imports of wood pulp into the United States in 1951 with countries of origin: Sweden—257,061, Finland—182,616, Norway—36,365, Russia—0, Austria—3225, Italy—0, Czechoslovakia—512, France—106, Germany—2812, Switzerland—89, Denmark—15. Total—482,801.

* * *

Of 21 billion packages of milk marketed annually, about 8 billion are in cartons made entirely of paperboard. The remainder, usually glass bottles, require closures made of paper or paperboard.

Of 10,970,000 tons of paperboard produced in the United States in 1950 about 766,000 tons or 7%, was foodboard, of which about 350,000 tons was sold on the market. The remainder was consumed in making containers and closures by converters owned and operated by paperboard mills.

Following are the grades of foodboard recently covered by the Office of Price Stabilization CPR 116. Special Paperboard, Food Container and Closure Paperboard:

1. *Milk Carton, Type I.* A dense, tough, bleached chemical pulp paperboard, suitable for forming into containers and waterproofing by application of paraffin either by the converter or in the dairy just prior to filling.

2. *Milk Carton, Type II.* A dense, tough, bleached chemical pulp paperboard, suitable for receiving application of vinyl plastic or similar coating and suitable for subsequent forming into containers. Required characteristics include smooth surface, high sizing, strength, and stiffness.

3. *Liquid-Tight Container Sidewall Stock.* A bleached chemical pulp paperboard, suitable for spiral winding on stationary mandrel to form sidewalls of liquid-tight paperboard cans.

4. *Two-Piece Cup and Round Nested Food Container Stock.* A bleached chemical pulp paperboard, hard-sized and having sufficient bending qualities to permit folding, crimping, beading, and forming into food containers with tapering sidewalls.

5. *Milk Bottle Plug Cap and Liquid-Tight Container Top and Bottom Stock.* A chemical, groundwood or combination chemical and groundwood pulp paperboard, lined or unlined, usually a stiff, hard-sized board with good printing and die-cutting properties.

6. *Milk Bottle Hood and Lip Cover Stock.* A bleached chemical pulp paperboard used in fabrication of sanitary production type of closure for milk bottles. The hood type which comes down the neck of the bottle requires a relatively stiff board which is receptive to plastic coating, and the lip cover type requires a board with good molding qualities receptive to waxing. Both types must have good printing surfaces.

7. *Cup Lid Stock.* A solid bleached chemical or combination chemical and groundwood pulp paperboard having stiffness and good printing and die-cutting properties.

8. *Solid Bleached Cartons Stock.* A solid bleached chemical pulp paperboard, usually water finished, made on fourdrinier or cylinder machines, generally used for making ice cream cartons, factory-filled ice cream pails, frozen food cartons, meat packages, carry-out ice cream pails and food pails, and for other food containers, usually paraffined, suitable for moist, liquid, and oily foods.

9. *Double-Bleached Line Carton Stock.* A double-bleached lined paperboard, usually water finished, cylinder machine board, used for making ice cream packages and other food containers, which are usually paraffined.

10. *Single-Bleached Lined Carton Stock.* A single-bleached lined paperboard, usually water-finished cylinder machine board, used for making butter, oleo, lard, and shortening cartons, frozen food packages, carry-out ice cream and food pails, and other food packages, which are usually paraffined.

11. *Solid Wood Pulp Board.* A solid wood pulp board, usually made from pulp, consisting of a major proportion of mechanical pulp and minor proportion of chemical pulp or its equivalent, generally used for making paper plates, closures, coasters, protective separators, and other similar products.

12. *Meat Board and Meat Tray Stock.* Meat board and tray stock, made of solid bleached chemicals pulp or a combination of chemical and groundwood pulp, or all groundwood pulp so treated as to resist penetration of blood, grease, meat juices and moisture.

* * *

The paper shipping sack industry produces two major product lines: (1) plant-packed shipping containers designed to carry 25 pounds or more as a primary container or as an overslip for the primary container, or as a container (baler) for assembly of a number of primary containers into a single shipping unit, and (2) plant-packed consumer packages, designed to carry 1 pound or more of the same products which are also packed in the larger shipping containers.

Generally all sacks are machine-made and produced in a wide variety of sizes, tailored to the individual buyer's requirements for packaging a particular commodity.

Production in the industry totaled 584,000 tons in 1949, 790,000 tons in 1950, and 671,000 tons during the first three quarters of 1951.

Twenty manufacturers producing nearly all types of shipping sacks account for 81% of total production. They include four fully integrated manufacturers who produce nearly all of the kraft papers they consume in making sacks, and 16 nonintegrated manufacturers who purchase most of the kraft papers they use. The four integrated mills account for about 46% of the industry's production and the 16 nonintegrated mills for about 35%.

The remaining 19% of production is from about 30 smaller converters who tend to specialize in certain types of sacks for specific industrial consumers.

* * *

West Virginia Pulp and Paper Co. produced and sold more paper, paperboard, and chemicals during fiscal year 1951 than for any year in its history, but net income for the period dropped $2,000,000, it was disclosed today in the company's annual report to stockholders.

Net income for the year ended October 31 was $10,326,000, compared to $12,262,000 in 1950. These earnings amounted to $10.80 per share in 1951, as compared to $12.93 in 1950.

David L. Luke, Jr., president, pointed out that the decline in earnings was a result of the rise in federal taxes which in-

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Production of Hooker Chemicals is at an all-time peak, and facilities are being expanded to meet new demands as promptly as possible. For up-to-date delivery information, please keep in touch with your Hooker sales representative.

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creased the company's income tax burden from $8,000,000 in 1950 to $13,500,000 in 1951.

In summarizing the results of the year Mr. Luke reported that tons of paper and paperboard sold during the year increased by 11%, from 682,000 tons in 1950 to 755,000 tons in 1951 and that dollar proceeds from such sales rose 22%, from $89,500,000 in 1950 to $109,400,000 in 1951. Sale of chemical products manufactured by the company increased by 18%, from $5,900,000 last year to $7,000,000 for the year just ended.

Consistent with these increases, the report shows, earnings before federal taxes also rose, by 18%, from $20,262,000 in 1950 to $23,826,000 in 1951.

"Had federal taxes remained at the level effective for 1950 and increased only in proportion to income," Mr. Luke pointed out, "the bill for 1951 would have been $9,400,000, leaving net income of $14,426,000."

From the net income of $10,326,000 realized in 1951, the company distributed $4,189,000 in dividends, at the regular rate of $4.50 per share on preferred stock and $4.00 per share on common, compared to $5.00 in 1950.

The remaining $6,137,000, together with $5,389,000 provided during the year for depreciation and depletion, was commingled with general funds and used, among other things, to pay for the company's continuing program of plant improvement and to carry the larger inventories and larger accounts receivable required by an increasing volume of business, the report stated.

Mr. Luke said that for those aspects of the business over which management had direct control—operating efficiency, quality, production, sales, and the like—1951 was by any measure one of the company's best years. He pointed out however, that purely external factors—taxes and inflation—create serious uncertainties for the future.

Since the end of World War II the company has carried on an extensive modernization and improvement program. The program, which has cost approximately $70,000,000 to date, thus far had been financed out of the company's own resources. Money spent for this work came from funds accumulated during World War II, when supplies and materials to keep the mills modern were not available, from funds provided to offset depreciation as the program went along, from proceeds from sales of mature timber on company woodlands, and from earnings, a good portion of which has been plowed back each year.

"Heavy taxes have seriously diminished the flow of earnings expected and needed to finance the program for the future," Mr. Luke said. "Progressive inflation has increased the price of materials and supplies and exaggerated the cost of construction."

These two factors, it was pointed out, made it necessary for the company to consider going to outside sources for money in order to continue its improvement program, leading to a decision made late in the year to borrow $20,000,000 by issuing debentures and to arrange a standby credit of up to $15,000,000 more, in order to have adequate funds on hand when and as needed.

* * *

Rayonier, Inc., today announced plans for the early construction of a new pulp mill at Doctortown, Ga., capable of producing 250 tons per day of purified wood cellulose. A mill site of 530 acres has been purchased and construction will be started as soon as steel and other materials requiring Government allocation are available.

In releasing this announcement, Clyde B. Morgan, President, stated that application has been made to the National Production Authority for a Necessity Certificate and for allocation of the necessary materials. The new mill will provide additional tonnage to meet the growing requirements of Rayonier's customers and at the same time will afford a reserve capacity for the possible manufacture of wood cellulose for military purposes.

Proceeds from the recently announced borrowing of $40 million from the Prudential Insurance Co. of America will be used in part to finance this project, which will constitute an investment in excess of $25 million.

Rayonier is one of the large producers in the United States of purified wood cellulose, a basic raw material used in the manufacture of rayon, tire cord, cellophane, photographic film, and other cellulose derivatives. The company already owns and operates three mills in the State of Washington and one mill in Florida, with combined annual capacity of approximately 430,000 tons. This fifth mill will have annual capacity of 87,000 tons.

A considerable enlargement of Rayonier's capacity is going forward at the present time in a $6 million special construction program at the four existing mills. This construction is expected to be completed in 1952. The Doctortown project is a further extension of the company's long-range expansion program, which has been planned to serve the steadily increasing demand for wood cellulose in the rayon, cellophane and related industries in the United States and world markets.

An advantageous location for the mill was selected in southeastern Georgia, on the Altamaha River, at a point 38 miles from the sea, in an area where there is an abundant supply of both surface water and ground water. The site in Doctortown, near Jesup, is served by the main line of the Atlantic Coast Line Railroad, with radiating rail connections and highway approaches affording economical transportation of pulpwood from the heavily wooded surrounding area.

The mill will use an improved process which permits the production of superior grades of wood cellulose, primarily for high tenacity yarn applications, such as tire cord, parachute materials, and rubber belting. Flexibility is provided in the mill's design, however, so that it will also be able to produce nitration pulp if necessary for the manufacture of explosives, as well as pulps for special types of paper and for standard textile yarns.

To provide an assured long-term supply of raw material for this new operation, Rayonier has recently enlarged its already substantial wood resources in the South, which had been built up to support production at the Fernandina Division in Florida. Large acreages have been purchased this year, and today, the company owns or controls approximately 400,000 acres in southeastern counties of Georgia and northeastern counties of Florida.

Approximately 550 cords of wood will be consumed per day, part of which will be drawn from Rayonier's own holdings of timber, and part will be purchased from local landowners, thereby creating a sizable new market for wood in the area. The mill is designed to use all the local species of pine, as well as the local hardwoods.

Approximately 450 people will be employed to work in the mill itself, and another 400 or 500 people will work in the cutting and transportation of pulpwood.

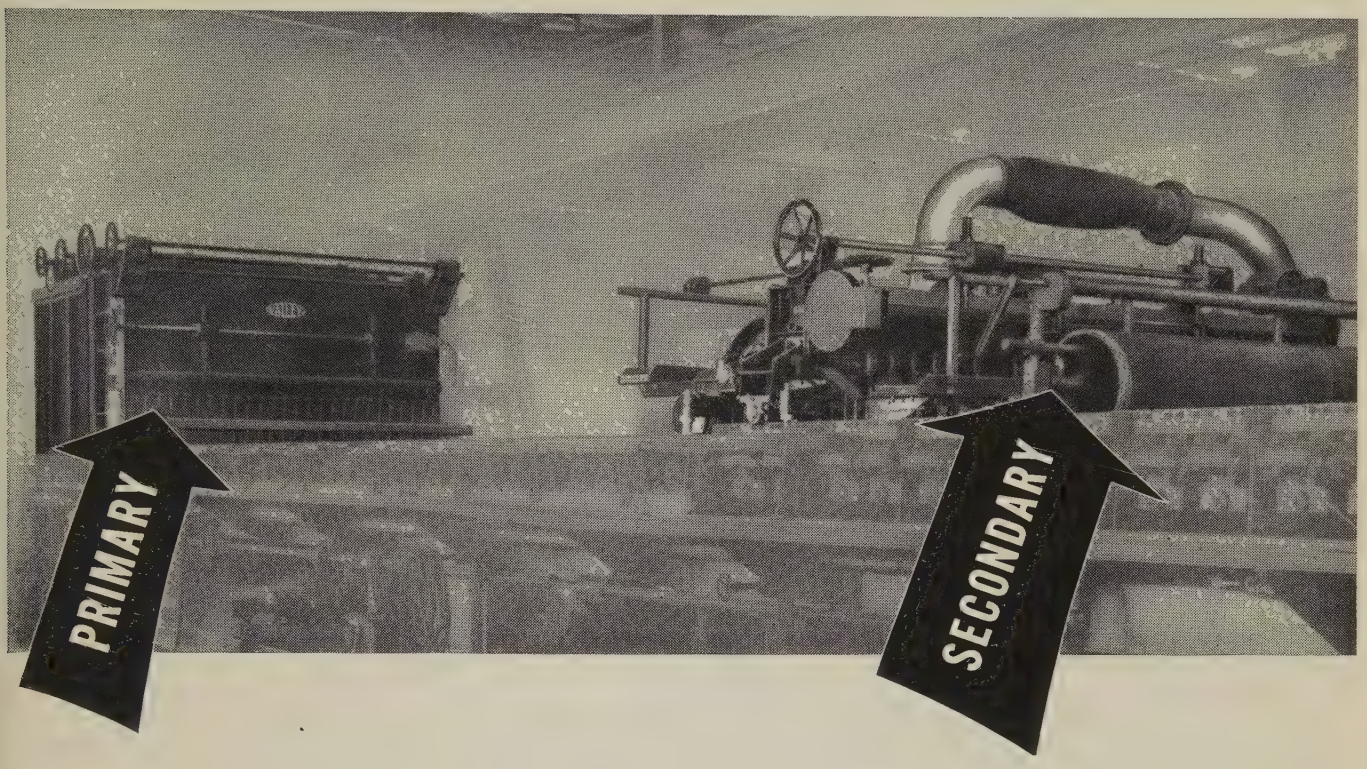
The Doctortown project will be carried out under the executive direction of R. F. Erickson, Vice-President in Charge of Engineering and Plant Development. The mill's special processing procedures were developed by Rayonier's Research Div. under the supervision of A. N. Parrett, Vice-President in Charge of Research and Development. Designs for the installation of the processing equipment have been prepared by Rayonier's own engineers, and Ebasco Services, Inc., has been retained as consulting engineers to design the mill structurally.

* * *

Eleven companies in the paper industry were awarded certificates of management excellence for the year 1951 by the American Institute of Management. These were: International Cellucotton Products Co., Chicago, Ill., Kimberly-

Longview Fibre Company's New #6 Machine

. . . with Inlet and Headbox by VALLEY*



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Clark Corp., Neenah, Wis., Northern Paper Mills, Green Bay, Wis., Champion Paper & Fibre Co., Hamilton, Ohio, Crown-Zellerbach Corp., San Francisco, Calif., Great Northern Paper Co., Millinocket, Me., International Paper Co., New York, N. Y., St. Regis Paper Co., New York, N. Y., West Virginia Pulp & Paper Co., New York, N. Y., Marathon Corp., Rothschild, Wis., and Scott Paper Co., Chester, Pa.

* * *

Construction has been started on a $1,300,000 plant designed to produce 400,000 pounds of vanillin annually by the Ontario Paper Co., Thorold, Ont. The Dow Chemical Co. has contracted for most of the plant's output.

* * *

The 21st Annual Conference on Packaging, Packing and Shipping will be held concurrently with the National Packaging Exposition on April 1–4 at the Public Auditorium, Atlantic City, N. J. The Exposition is sponsored by the American Management Association.

* * *

The Deerfield Glassine Co. has announced that construction has been started on its new mill in Quebec, Canada. It will be called Canadian Glassine Co. It will be located adjacent to the properties of Anglo-Canadian Pulp and Paper Mills Ltd. from whom wood pulp will be obtained in slush form through a pipe line. Anglo-Canadian will have a minority interest in the new concern. The President will be Paul E. Hodgdon, the President of Deerfield Glassine Co. The sales of the production will be in the hands of Acer McLernon Co., of Montreal. Production is expected to start in June, 1952. The mill will employ 100 persons. It will be a one-machine mill having a 108-inch fourdrinier. Production will be about 4000 tons per year. The cost is estimated at one million dollars. R. E. Stewart Construction Corp. are the contractors.

* * *

The Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich., has announced the election of James A. Marohn as Vice-President in Charge of Finances. Mr. Marohn has been Vice-President and Treasurer of Noma Electric Corp., New York, N. Y.

* * *

Olin Industries, Inc., has established a research laboratory to evolve new and improved cellophane, polyethylene, and other packaging films on the site of the Winchester Repeating Arms Co. at New Haven, Conn. Edward Hartshome has been named Manager of the new department. The work of the Research and Development Dept. will be carried out under the general supervision of Fred Olsen, Research Director of Olin Industries, Inc.

* * *

A program in pulp technology is being established by the School of Forestry, North Carolina State College, at Raleigh, N. C. An individual qualified to develop a pulp and paper department is desired by the college.

* * *

Robert Gair Co., Inc., of New York City has purchased the American Coating Mills Div. of Owens-Illinois Glass Co. at Elkhart, Ind. The deal is expected to be completed by April 1. Under the transaction Gair will acquire the paperboard mills at Elkhart and Middletown, Ohio, and carbon fabricating plant at Elkhart, Chicago, and Grand Rapids. The business of American Coating Mills will be operated as a separate division of Gair under the direction of R. L. Sniderman, President of American Coating Mills.

Robert Gair Co., Inc., has completed a shipping container plant at Teterboro, N. J. Operation began at the end of January. Most of the present box ship personnel at Gair's Bogota Div. have been transferred to Teterboro. Planning and operation of the plant was under the direction of John Warner, Gair's Chief Engineer.

* * *

The Sixth Annual Convention of the American Society for Quality Control will be held at the Onondaga War Memorial Auditorium, Syracuse, N. Y., on May 22–24, 1952.

* * *

New York University is giving a course of lectures in pulp and paper under the direction of Leonard Schlosser, Vice-President of the Schlosser Paper Corp., New York, N. Y.

* * *

Three of the leaders of the Japanese pulp and paper industry were awarded the Murdock Medal on October 30, 1951. This medal which was instituted in 1947 has become a valuable symbol which, according to the Japanese, commemorates the great help given by the United States in the reconstruction of the Japanese industry. The following complete list of medalists includes the first three Presidents of Japanese TAPPI, Messrs. Nakamura, Nishi, and Seki. The other members are outstanding leaders in their respective fields:

1948—Harold R. Murdock (now in Atlanta, Ga.)
1949—Shigeo Kanai, President, Kokoku Rayon & Pulp Co. Ltd.
Itsuki Nishi, President, Jujo Paper Mfg. Co. Ltd.
Hisashi Nakamura, Vice-President, Hokuetsu Pulp & Paper Co. Ltd.
1950—Yoshikumi Seki, Managing Director, Mitsubishi Paper Mills, Ltd.
1951—Junichiro Kobayashi, President, The Council for Integrated Counter Measures for Forest Resources
Ryosaku Takata, President, Tokoku Pulp Co.
Saijiro Inouye, Managing Director, Adawara Paper Mfg. Co. Ltd.

* * *

The United States led the world in newsprint consumption in 1950, but it stood only seventh in circulation per thousand population, according to the United Nations' 1951 Yearbook.

It was the size of its papers, the Yearbook indicated, that placed United States first among the newsprint consumers, using more than 60% of the world supply.

The United Kingdom, according to the Yearbook, had the highest daily circulation in 1950 in proportion to the population with 599 copies per 1000 inhabitants.

Following in this order were: Australia, 455 copies per thousand; Luxembourg, 441; Sweden, 416; Norway, 415; Denmark, 414; United States, 357, and Switzerland, 354.

* * *

Harold R. Bonnyman has been named Sales Manager of Bird & Sons, East Walpole, Mass., Container Dept. He succeeds L. S. Wright, who resigned to become Assistant to the President of the Hopper Paper Co., Taylorville, Ill.

* * *

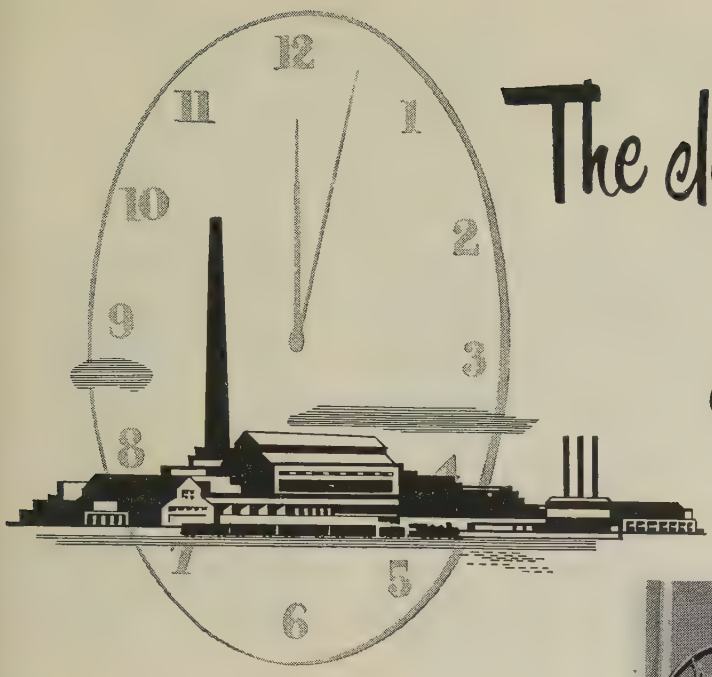
Thomas Leech has been elected Vice-President and General Manager of the Whiting-Plover Paper Co., Stevens Point, Wis., succeeding A. J. Schierl.

* * *

The Annual Meeting of the Forest Products Research Society will be held at the Hotel Schroeder, Milwaukee, Wis. on June 23–25, 1952.

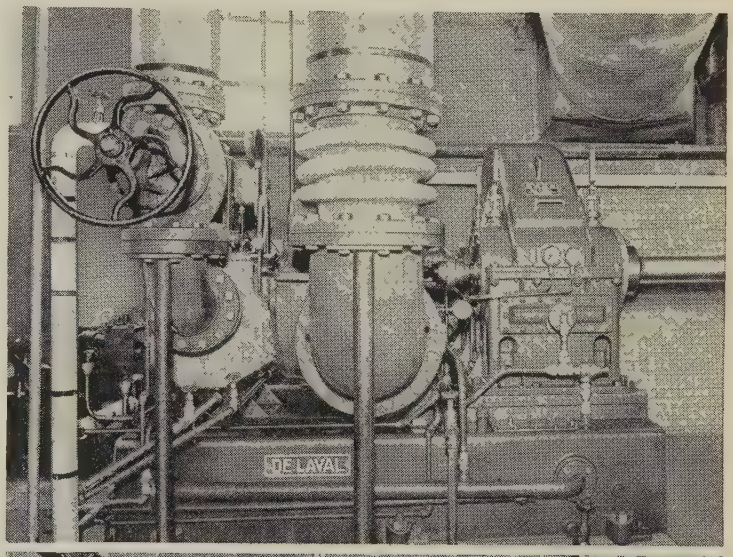
* * *

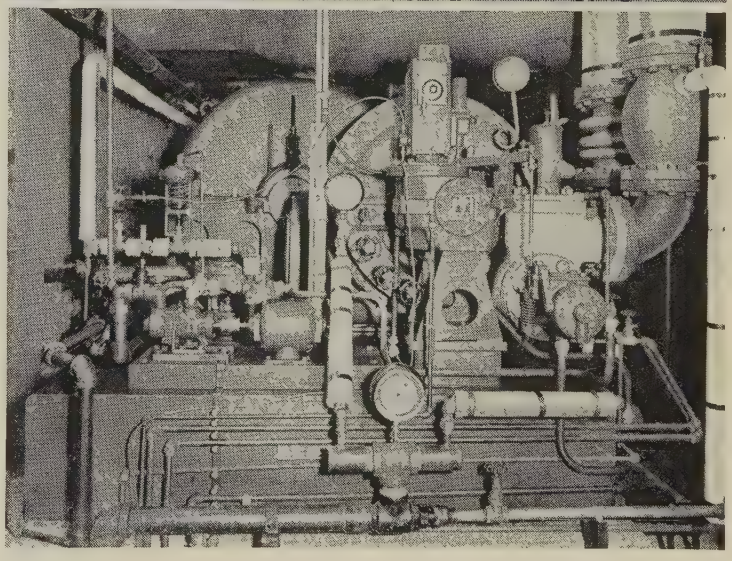
The Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis., is testing equipment that was originally designed for making drinking water from salt water for Navy ships to evaporate excess water out of spent sulphite liquor. All methods which have thus far proved to be technically capable



The clock never stops on this

DE LAVAL
GEARED TURBINE
AT FINCH, PRUYN





Round-the-clock papermaking requires peak turbine dependability. That's why Finch, Pruyn selected this 400 hp geared De Laval multistage turbine to drive their new 122-inch Pusey and Jones Fourdrinier machine.

With a maximum speed change of 7.5 to 1, this De Laval turbine provides a wide range variable speed drive. It offers a maximum capacity rating of 525 bhp at 4945 rpm with a gear reduction to 480 rpm. Minimum operating turbine speeds go as low as 659 rpm geared to 64 rpm.

Anticipated future operation of this paper machine at 1200 feet per minute will utilize the turbine's top speeds. Currently the machine is producing at the rate of 1,000 feet per minute, requiring 375 hp at 4130 rpm geared to 400 rpm.

De Laval engineers are old hands at making turbines that stay on the job year after year. Investigate the De Laval line now. Best way to start is with Bulletin 4200-A. Write for your copy today.

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DL-115

of concentrating sulphite liquor to burnable density are so costly that there remains some question as to their economy relative to the cost of producing pulp. The preliminary tests are being made on spent liquor from a neutral sodium semi-chemical pulping operation. The next step is to operate the equipment on spent sulphite liquor long enough to note if complications arise. If successful, the final step will be to have the equipment made of corrosion-resistant alloys and run on a commercial scale.

* * *

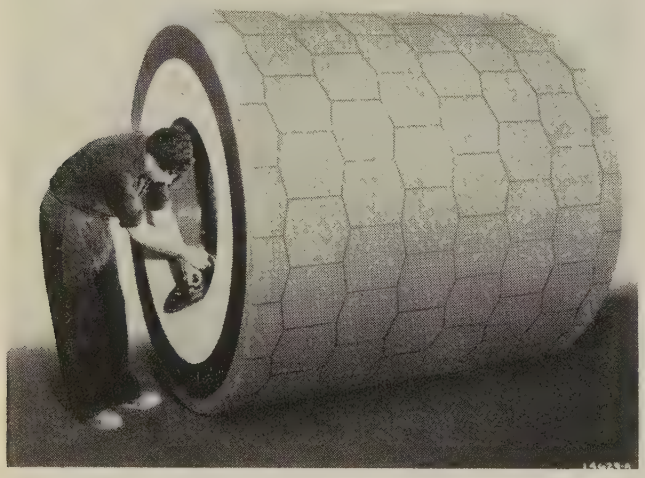
The University of Maine, Pulp and Paper Foundation, Orono, Me., has issued an interesting kit "Daily Dividends." The Semi-Annual Report to Members is included. Copies may be obtained from Howard A. Keyo, Publicity Director.

* * *

John W. Bolton & Sons, Inc., has issued its bound volume containing the prize-winning papers entered in its essay contest on "Why Profit Is Everybody's Job." Winners this year included: O. E. Anderson, International Paper Co., Chisholm, Me.; Sidney A. Brown, Rogers Corp., Manchester, Conn.; J. H. Groves, Union Bag & Paper Co., Savannah, Ga.; W. F. Hathaway, Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich., and Dean W. Newell, Philip Carey Mfg. Co., Lockland, Ohio, all of whom are members of the Technical Association.

* * *

The largest pulpstone ever made was shipped recently to a paper mill in British Columbia by the Norton Co., Worcester, Mass. This stone measures 67 by 69 inches and weighs $10^1/_2$



Largest pulpstone ever made manufactured by the Norton Co.

tons. It is made of silicon carbide (Crystolon) abrasive and will be used in making groundwood for newsprint paper. It is the first of several ordered by the Canadian company. Five thousand horsepower will be required to drive this pulpstone 5000 surface feet per minute.

* * *

The December issue of *Monsanto Magazine* is dedicated to the fiftieth anniversary of the company. It is an extremely readable issue and a copy should be obtained by any company or individual that is interested in the products of this company. Copies may be obtained from the Merrimac Div., Monsanto Chemical Co., Everett Station, Boston 49, Mass.

* * *

The De Laval Steam Turbine Co. has announced the formation of a subsidiary corporation, De Laval Turbine Pacific Co., with headquarters at Main and Folsom Streets, San Francisco, Calif. C. F. Reeves, Vice-President and General Manager, will be in direct charge of operations.

* * *

J. Delano Hitch, formerly Vice-President in Charge of Sales, has been promoted to the position of Executive Vice-President of the Dorr Co., Stamford, Conn. Bartow Ford, until recently Manager of International Sales, succeeds Mr. Hitch as Vice-President in Charge of Sales.

J. Delano Hitch, Dorr Co.

T. Bartow Ford, Dorr Co.

* * *

Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill., has issued a 24-page book (No. 2444) on Positive Action Oscillating Conveyors for handling wood chips and other materials.

* * *

F. C. Huyck & Sons, Rensselaer, N. Y., has acquired Joseph Noone's Sons Co. of Peterborough, N. H. The Noone organization has produced industrial mechanical cloths since 1831.

* * *

The National Adhesives Div. of National Starch Products, Inc., 270 Madison Ave., New York, has added to its line of vinyl acetate copolymers, water emulsions as well as solvent solutions of these materials. These are used in heat-seal coatings, greaseproof coatings, adhesive formulations, and binder for paper, fibers, etc.

* * *

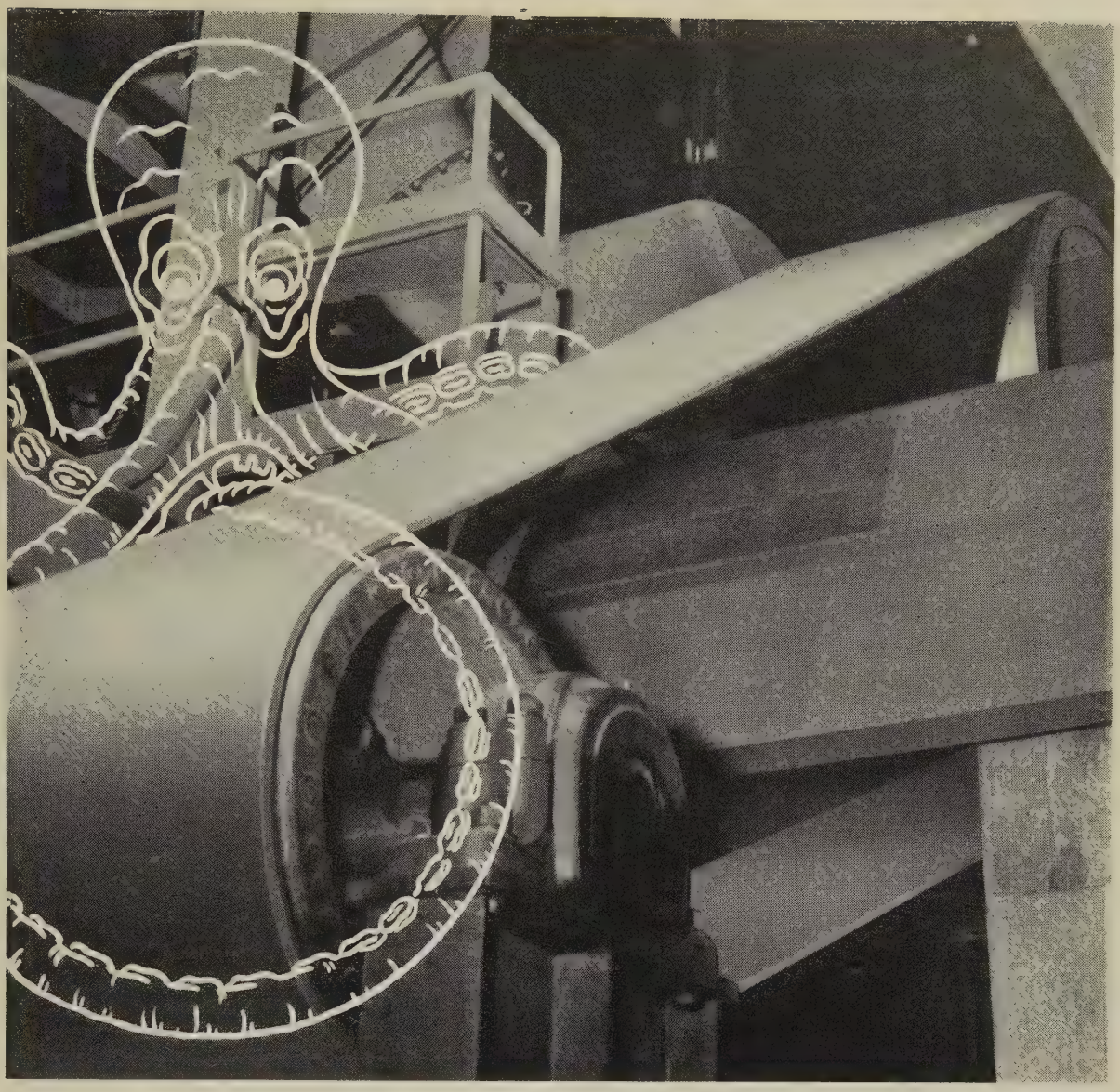
The six basic fields in which radioactive materials may be used in the solution of industrial problems, are outlined in the November issue of *Tracerlog*, the house organ of Tracerlab, Inc., 130 High Street, Boston, Mass. Tracerlab's beta gage is used in the paper industry for measuring the weight per unit area of sheet materials. The company also supplies Cobalt-60 radiography sources for the nondestructive inspections of castings, welds, and fabricated metal products, such as pressure vessels. Copies of November *Tracerlog* may be obtained from the company, on request.

* * *

Frederick A. Soderberg, Manager of the Industrial Div. of General Dyestuff Corp., has been elected chairman of the Chemical Marketing Subdivision of the American Chemical Society.

* * *

A. E. Staley Mfg. Co., Decatur, Ill., has entered into an agreement with the Chase National Bank of New York under which it can obtain an 8 million dollar loan for additional working capital any time until the end of 1953. A multimil-

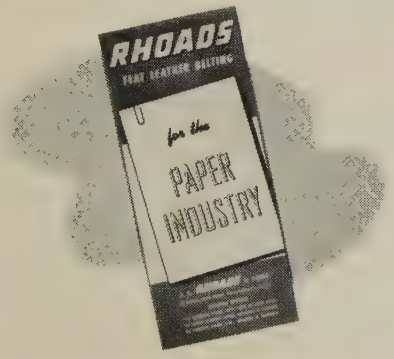


RHOADS Tannate® LEATHER BELTING

Gives You Uniform Grip Across and Around the Face of the Pulley

Like the "clingability" of an octopus, Rhoads Tannate Leather Belting, too, has a live, dynamic, gripping and pulling surface. Another similar characteristic is Tannate's self-adjusting elasticity; this permits full absorption of shocks and overloads, provides a cushioning effect that minimizes wear on motor and machine bearings . . . These characteristics are not by accident, but are "custom-engineered" into every Rhoads Tannate Leather Belt especially for the paper industry. Because of these qualities, Rhoads Tannate will out-pull and out-last other good belts — effecting lower belt costs per unit of production. Ask your Rhoads sales engineer for details, or write J. E. Rhoads & Sons, 35 N. Sixth Street, Philadelphia 6, Pa.

Write for "Rhoads Industrial Leathers for the Paper Industry."



250th ANNIVERSARY YEAR

J. E. RHOADS & SONS
PHILADELPHIA • NEW YORK
CHICAGO • ATLANTA

lion construction program, now substantially complete, has been financed out of earnings.

Ivan F. Wieland has been promoted to the newly created position of Assistant to the Corn Div. Manager of Staley. Richard L. Nagle has been named Industrial Sales Manager.

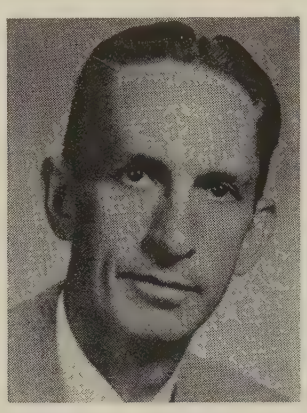
* * *

The Dicalite Div. of Great Lakes Carbon Co., 612 South Flower Street, Los Angeles 17, Calif., has issued Technical Bulletin B-12W on Clarification of Water by Filtration.

* * *

John F. Butterworth, formerly of New York City, has been advanced to a new assignment with the Lubrite Div. of Socony-Vacuum Oil Co. in St. Louis, Mo. Mr. Butterworth will

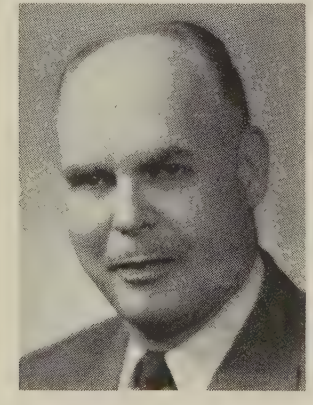
J. F. Butterworth, Socony-Vacuum Oil Co., Inc.



W. S. Kumblad, Socony-Vacuum Oil Co., Inc.

be responsible for sales and service of process products in the five states around St. Louis. He was formerly Secretary of the TAPPI Empire State Section, Metropolitan District. Mr. Butterworth is being succeeded at New York by Warren S. Kumblad, formerly with the New England Div. and Bird & Sons. Harold E. Corbin, formerly of St. Regis Paper Co., assumes Mr. Kumblad's former position in New England.

H. E. Corbin, Socony-Vacuum Oil Co., Inc.



K. H. Cree, Western Precipitation Co.

* * *

Western Precipitation Co., pioneers in the commercial application of Cottrell electrical precipitation processes for recovering dusts, fumes, etc., from industrial gases has opened a new office at 1429 Peachtree Street, N. W., Atlanta, Ga. The office will be in charge of K. H. Cree. The office will serve the southern states east of the Mississippi River.

* * *

Private Wire, a publication of the American Brake Shoe Co., conducted a management quiz "What do you think are the ten most important factors to watch in the management of a business today?" The voters cast their ballots giving preference to the following order: (1) the attitude of the workers, (2) control of expenses, (3) research, (4) equipment, (5) accounting methods, (6) employment of new people, (7) profit margin, (8) sales, (9) ratio of current assets to liabilities, and (10) investment portfolio.

* * *

J. E. Rhoads & Sons, 35, N. Sixth Street, Philadelphia, Pa., has issued a folder on "Tannate Leather Belting for the Paper Industry."

* * *

Westinghouse Electric Corp., East Pittsburgh, Pa., has issued a 16-page pamphlet (Section 27) on "Safety Rules for Electrical Maintenance and Construction Men."

George E. Goodrich has been appointed Assistant Manager of the Industrial Dept. of the Westinghouse Apparatus Div.

The January, 1952, issue of Westinghouse Engineering *Highlights* gives an excellent review of the new developments of the company in 1951.

* * *

Richard H. Dexter has been employed as a sales engineer in the Water Filtration Equipment Div. of Holyoke Machine Co., Holyoke, Mass.

* * *

Solvay Sales Div., Allied Chemical & Dye Corp., 40 Rector Street, New York 6, N. Y., has issued two new and excellent booklets. An 84-page edition of its Technical and Engineering Bulletin No. 6 covers "Caustic Soda, Properties, Solutions, Unloading and Handling." A 57-page Bulletin No. 7 covers "Liquid Chlorine—Its Properties, Transportation Equipment and Safe Handling."

* * *

At the stockholders' meeting of the Cowles Co., Cayuga, N. Y., Edwin Cowles was elected President; Arthur W. Infanger, Vice-President and Chief Engineer; Horton Meyer, Vice-President and Sales Manager; and Edward Rogers III, Secretary and Treasurer.

* * *

Branson Instruments Co., 436 Fairfield Ave., Stamford, Conn., has issued a bulletin and several data sheets in reference to its Audigage, an instrument for estimating metal wall thicknesses without destructive drilling and plugging. Results obtained at the Crossett Paper Mills are given.

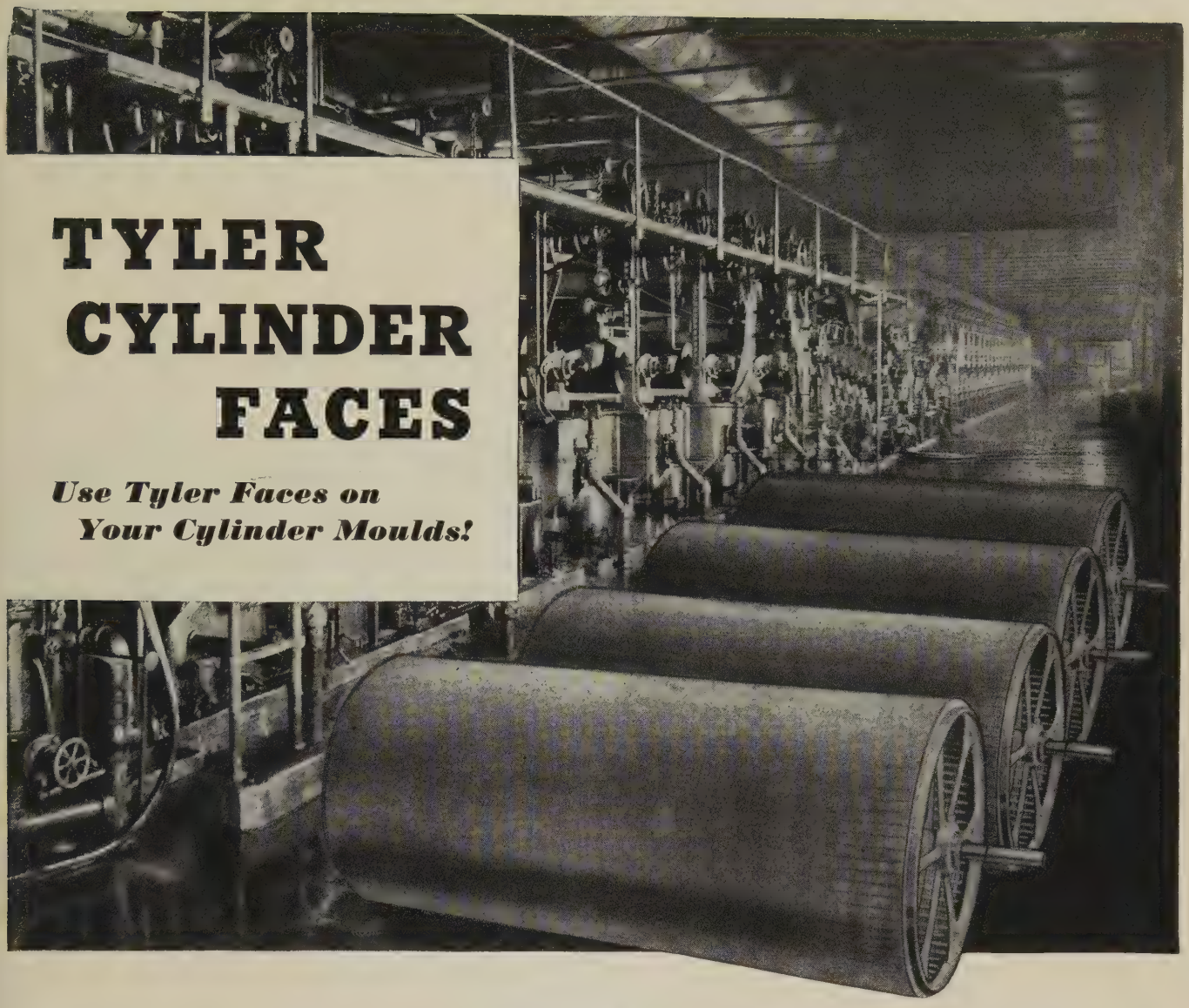
* * *

Paisley Products, Inc., has purchased the plant, equipment, formulas, and manufacturing processes of the 50-year-old Layton Elastic Glue Co. of Chicago. The Layton firm is well known throughout the graphic arts, bindery, paper converting, wallpaper, and industrial manufacturing fields. Paisley Products, Inc., is a subsidiary of Morningstar, Nicol, Inc. of New York, N. Y.

* * *

E. I. du Pont de Nemours & Co., Inc., has awarded 75 postgraduate fellowships to 47 universities and grants-in-aid to 15 universities to "stockpile": knowledge through the support of fundamental research. They are for the academic year 1952–53. The awards amount to $510,000 and are unrestricted in the field of fundamental chemical research. It is expected that the program will help maintain the flow of technically trained men and women into teaching and research work at universities and into positions in industry.

Du Pont has discontinued allocations of cellophane. The



TYLER CYLINDER FACES

Use Tyler Faces on Your Cylinder Moulds!

TYLER Fourdrinier Wires

Cylinder Wires **Filter Cloth** **Washer Wires**

Hum-mer Electric Screen For Wet Screening of Coatings, Colors and Fillers

Tyler-Niagara and Ty-Rock Chip Screens

TY-Rocket Screens For Heavy Screening of Machine Coatings

THE W. S. TYLER COMPANY, CLEVELAND 14, OHIO

product has been in short supply since 1942. Production was substantially increased in 1951.

A new technical bulletin "Neoprene Treated Paper" describes the properties (wet strength, internal bond, impact strength, and chemical resistance) that can be obtained in various kinds of paper by adding a few per cent of neoprene rubber latex to the paper pulp. The bulletin may be obtained from Du Pont Rubber Chemicals Div., Wilmington, Del.

Roy E. Troutman has been appointed Sales Manager for White Pigments by Du Pont's Pigments Dept. Mr. Troutman has been engaged in chemical research and sales of pigments since 1925.

Stuart P. Miller has been advanced to the position of Manager of Sales to the paper, textile, and leather industries of Du Pont's Polychemicals Dept. Albert A. Pavlic has been advanced to Assistant Manager of Sales.

* * *

Babcock & Wilcox has started construction of a new plant in Paris, Tex. The plant will manufacture large industrial boilers.

* * *

Hercules Powder Co., Wilmington, Del., has issued a new 12-page booklet on Kymene, a cationic resin for wet-strength papers. Suggested procedures for determining resin retention, total solids of Kymene solutions, wet tensile strength, and wet burst are included in the section on testing procedures.

Construction expenditures of Hercules in 1951 amounted to 15 million dollars. The research outlay was $5,433,000.

Revised information about a series of resin emulsions containing 40–45% solids is available in a new leaflet from Hercules. The leaflet is entitled "Dresinol." Dresinol is used for heat-sealing, wet-type adhesives, laminating, coatings, and sizings.

Hercules Powder Co. Synthetics Dept. announces the appointment of Henry A. Thourm as Assistant General Manager and James W. L. Monkman as Director of Sales.

* * *

Reliance Electric Co., 1088 Ivanhoe Road, Cleveland 10, Ohio, has issued a new V-S Drive Bulletin (D-2311). Application of this equipment to seven typical manufacturing operations is illustrated.

* * *

Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Station 40, Wayne & Windrim Aves., Philadelphia 44, Pa., has issued catalog 6020 on Cam Programmer Thermometers for time-temperature control.

* * *

Pennsylvania Salt Mfg. Co. of Philadelphia, Pa., was selected as one of the ten best managed corporations of 1951. More than 3000 corporations were studied by the American Institute of Management. The following ten categories were considered in making the selection: economic function, corporate structure, health of earnings, growth, fairness to stockholders, research and development, directorate analysis, fiscal policies, production efficiency, sales vigor, and executive evaluation.

* * *

Raybestos-Manhattan, Inc., Manhattan Rubber Div., Passaic, N. J., has issued a new bulletin (6830B) describing the "New Improved Manhattan Single Groove V-belts."

* * *

The Dow Chemical Co., Midland, Mich., has established a microbiological laboratory as a section of the biochemical research department. Paul A. Wolf has been placed in charge of the new laboratory. Efforts of this section will be directed toward the development of new germicides and fungicides for control of bacteria, molds, and yeasts that cause deterioration of industrial products such as paper. Dr. Wolf was formerly with the Michigan Dept. of Health.

* * *

Kenneth C. Towe was elected President of the American Cyanamid Co. He succeeds Raymond C. Gaugler who died in January, 1952. Mr. Towe has been associated with the company since 1926 when he joined the company as an accountant.

* * *

KVP now produces vegetable parchment in Canada. Manufacture and sale are by the two KVP Canadian subsidiaries. The KVP Company Ltd., Espanola, Ont., made the first parchment on January 11 and is already producing an excellent grade. This is the big new sulphate pulp mill built in 1946. A portion of its 275-ton daily production is being made into pulp suitable for waterleaf, which is made on one of the two paper machines also in operation there.

K. C. Towe, American Cyanamid Co.

A new building of reinforced concrete, cement block, and brick construction has been built for the parchment operations. It is 55 by 225 feet with full basement. One parchment machine has been installed, with room for a second when needed. The parchment machine is a Pusey Jones unit.

The wet end included all the latest developments in design that 42 years of KVP experience in the manufacture of genuine vegetable parchment have developed.

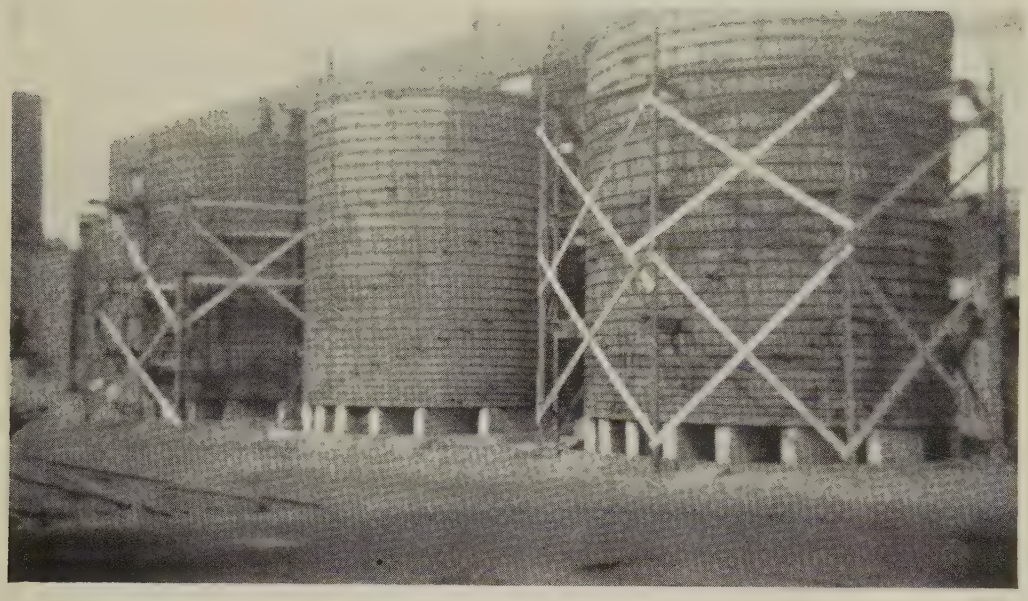
Driers have an 86-inch face and will produce a sheet 76 inches wide.

The machine is driven by a Louis-Allis variable speed a.c. motor. Auxiliary equipment includes a Whiting acid evaporator, the first of its kind to be built in Canada.

Weights and types now in the most common use will first be produced, but the plant will shortly be making a wider line than has been available.

The KVP Co. Ltd. mill at Espanola, Ont.

ENGINEERED TANKS



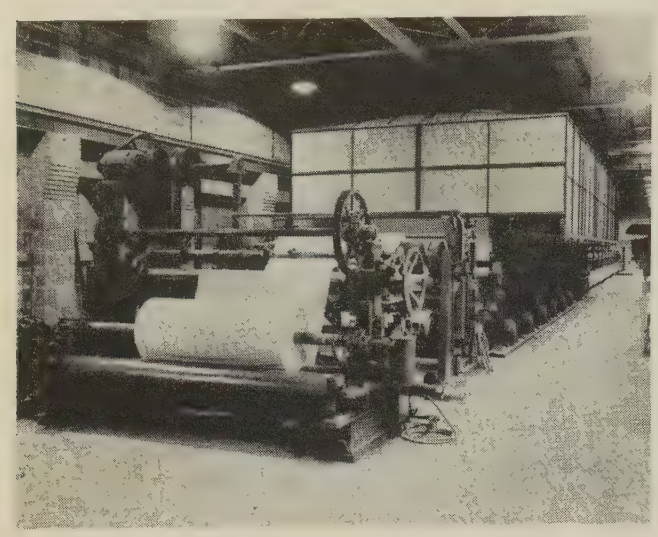
HAUSER-STANDER PAPER MILL TANKS

ENGINEERS and TECHNICAL MEN
WANT
SOUNDLY ENGINEERED PRODUCTS.

WE MAKE THEM

THE HAUSER-STANDER TANK CO.
CINCINNATI 32, OHIO

Conversion and sale of the KVP vegetable parchment are by Appleford Paper Products, Ltd. of Hamilton, Ont., acquired by KVP in 1945, and recently moved into a new and modern plant. Appleford is Canada's largest producer of household waxed papers (Food Saver and Save-All) and the



The new parchment machine at the KVP Espanola mill

leading source of supply to the dairy industry for printed butter wrappers. It also makes milk bottle tops, waxed papers for bread and carton sealing operations; waxed glassine bags; sales books; place mats; baking cups; printed parchment for the meat, dairy, and vegetable industries; and a wide line of food protection papers similar to those produced by KVP in the U. S.

A new booklet has been put out by the Vegetable Parchment Manufacturers Association, 122 E. 42nd St., New York 17, N. Y., giving further data on the properties of genuine vegetable parchment.

The parchment will be available plain or printed. Appleford has multiple color presses and many years of printing know-how.

The plain parchment will be available to Canadian converters other than Appleford.

The addition of the vegetable parchment plant is in line with the KVP policy of complete integration of pulp, paper, and converting operations.

It has been of considerable interest to the community at Espanola, as it has meant the addition of new employees and provides further outlet for the pulp and papermaking products. Espanola is a former "ghost town" which was revitalized when KVP purchased the old Abitibi groundwood mill that had been idle for 13 years, and built the big sulphate mill. More than 1200 men and women are now employed, with many hundred more in the woods operations which cover some 6500 square miles.

Those in charge of the operations including over-all supervision by A. Southon, President of the Kalamazoo Vegetable Parchment Co., are as follows:

E. Norval Hunter, KVP Vice-President in Charge of Canadian operations
Ben Avery, President, The KVP Company Ltd.
Don Best, Manager of Manufacturing
Homer Ralph, Superintendent of the new parchment plant

At Hamilton:

George Clark, President, Appleford Paper Products, Ltd.
Colin Glassco, Vice-President and Manager of Manufacturing
Ron Williams, General Sales Manager
Fred Inglis, Parchment Sales Manager

EMPLOYMENT SERVICE

POSITIONS OPEN

P190-52. Sales Engineer, chemical or mechanical, with experience in sulphate mill recovery operations and equipment. Reply should include personal data, résumé of experience, photograph, if available, and telephone number. Our employees know about this advertisement. Company located in the south.

P191-52. Kraft Mill Superintendent. A large pulp and paper company located in southeastern Quebec has an immediate opening for a superintendent for its 300-ton kraft mill. Applicant should be fully experienced in mill operations, in control and the study of technical problems, and in handling men. Graduate mechanical or chemical engineer with some engineering experience preferred. Knowledge of French considered an asset. Salary open. Please give full particulars of experience, education, age, etc., with first reply which will be considered confidential. Our staff has been advised of this advertisement.

P192-52. Pulp and paper experts for employment for one year by the Food and Agriculture Organization of the United Nations to make preliminary surveys in a region composed of several neighboring countries to determine the possibilities of new pulp and paper mills. Salaries to be paid in U. S. currency between $9000 and $10,000 a year and in addition a *per diem* allowance of $12.50 plus all travel expenses. Applicants must speak English or French fluently.

P193-52. Young Engineer. Familiar with pulp and paper processes for position as assistant project engineer with machinery company in New York.

P194-52. Assistant or Associate Professor of Pulp and Paper Technology for midwest college. Technically trained man interested in teaching but without experience in a university will be considered.

P195-52. Pacific Coast container company seeks man for research work on plastics, waxes, and adhesives as applied to folding cartons. Salary commensurate with experience and ability.

P196-52. Sales Engineer. Midwestern manufacturer of pulp and paper mill specialty machinery wants personable young man with mill experience to work in sales department. Approximately two-thirds of time will be spent at home office handling correspondence with customers. One-third of time will be spent in traveling. Give full details of personal, education and experience background.

P197-52. Mechanical Engineer. Interest or knowledge in construction with structural steel. College degree in engineering. Married man preferred who desires to live in small town in New York State. Salary $5600 to $6200 per year. Excellent opportunity.

P198-52. Superintendent for lightweight fine and rag paper mill in New York State.

P199-52. Technically trained man to supervise quality control in New York State paper mill making high grade lightweight rag and woodpulp papers.

POSITIONS WANTED

E157-52. Paper Chemist. B.A. in pulp and paper technology, June, 1952. B.S. in chemistry, 1949. More than two years' experience as a chemist in a pulp and paper mill. Married.

WANTED

A New Product

Medium size mill in the East manufacturing Special cylinder papers would like to add to its diversified line. Twenty-five – fifty-ton lots considered.

Those submitting successful suggestions will receive due consideration.

Reply TAPPI, Box AA-52

122 E. 42nd Street, New York 17, N. Y.

Age 26, Veteran. Desires position in production or development work on the Pacific Coast.

E159-52. Graduate Pulp and Paper Chemist. Fifteen years' diversified experience. Seeking position as technical assisant to manager of progressive board, paper, or roofing felt mill. Résumé and references upon request.

E160-52. Chemical Engineer, 28. Six years' diversified development and control experience in paper and paperboard manufacture desires position with progressive company. Presently employed.

E161-52. Chemical Engineer, 3 years Institute of Paper Chemistry, 4 years' experience industry and government, desires position production end pulp, paper or allied industry. Prefer location Wisconsin or northern Illinois. Résumé and references on request.

E162-52. Starch and Coating Development Chemist. Eleven years' experience with all types industrial adhesives and with paper coatings in paper mill. Responsible production on sales opportunity desired. Midwest preferred.

E163-52. Technically trained man, 38, familiar with coated and uncoated book and groundwood papers. Experienced in technical control with practical operation in deinking and as groundwood superintendent. Desires assistant superintendent, technical superintendent, groundwood superintendent or other work along these lines.

E164-52. Technical saleman, BS in Chemistry, desires position in North East representing chemical supply firm. Has had experience in Mid-Atlantic States.

E165-52. Chemical Engineer, pulp and paper graduate of New York State College of Forestry, with over 20 years' experience in paper industry desires position in paper mill or as technical sales representative.

E166-52. Graduate Chemical Engineer with 15 years' extensive experience in both northern and southern pulp and paper mills. Pulping, bleaching, stock preparation, and mill control. Desires responsible position with specialty mill or company manufacturing sulphate pulp and paper.

FOLDING BOX CONFERENCE

Lake Erie Section of TAPPI

Statler Hotel

CLEVELAND, OHIO

MAY 22–23, 1952

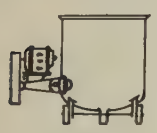
NEW MECHANICAL SEAL SOLVES CORROSION AND TEMPERATURE PROBLEMS

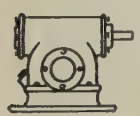
CHICAGO, ILLINOIS
Hard to handle liquors now being successfully coped with reports now

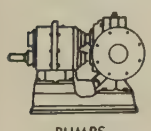
"JOHN CRANE" MECHANICAL SEAL WITH TEFLON★

With the new Type 9 John Crane Mechanical Seal, proper sealing of corrosive liquors is no longer a factor. Its flexible wedge and sealing rings are molded of the spectacular new plastic, Teflon, which is not affected by any industrial chemical.

The successful development of two years research and field testing, this revolutionary seal handles corrosive liquids never before controlled effectively by conventional, flexible type mechanical seals. Thus, John Crane designing experience is effectively combined with the unique properties of Teflon: chemical inertness, extremely low friction and high heat resistance. Type 9 Seal can be employed at temperatures up to 500°F.


MIXERS AGITATORS

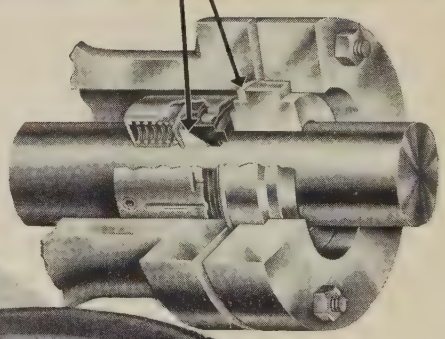

SPEED REDUCERS

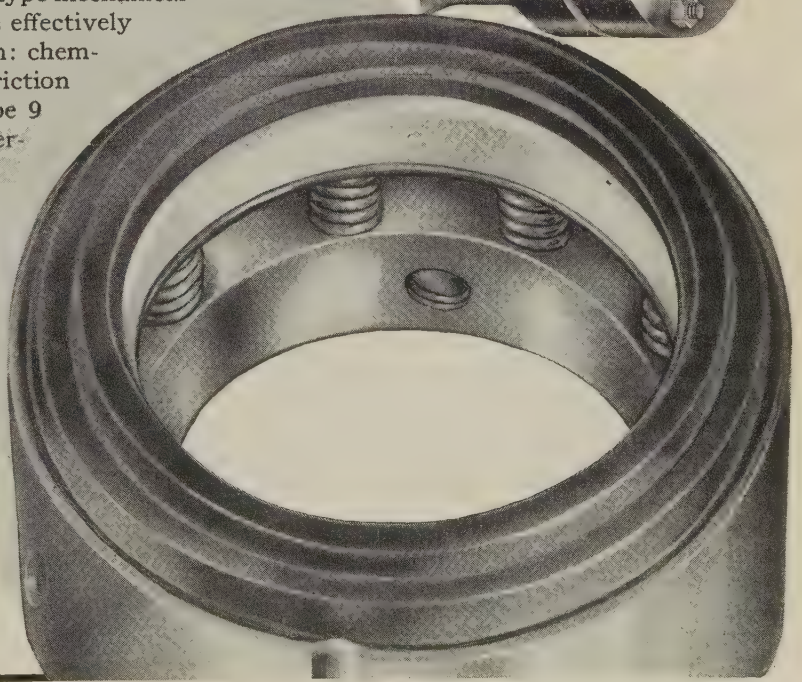

PUMPS

Write today for NEW Booklet describing the John Crane Type 9 Shaft Seal.

Other John Crane Seals available for pumps handling paper stock, clay coating, etc.

JOHN CRANE





CRANE PACKING COMPANY
1809 BELLE PLAINE AVE. • CHICAGO 13, ILLINOIS
Offices in All Principal Cities in United States and Canada

LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel and Events

Chicago

The second annual corrugating conference was held by the Chicago Section of the Technical Association of the Pulp and Paper Industry on January 21. The afternoon and evening sessions held at the Chicago Bar Association featured six speakers who covered various aspects of the subject such as quality control, practical operating problems, and customer reactions. Over 130 persons were in attendance at the meeting which was presided over by Vance V. Vallandigham, of Kelco Co., who is Chairman of the TAPPI Chicago Section. G. A. Zinkil, special representative, Central Fibre Products Co., Quincy, Ill., was moderator of the conference which presented the following speakers and subjects listed below:

"Component Materials Required," by G. A. Farrah, Assistant to the Vice-President, National Container Corp., Tomahawk, Wis.
"Operation of the Corrugator," by R. T. Cassady, Vice-President, The Jackson Box Co., Cincinnati, Ohio
"Quality Control in the Box Shop," by M. L. Hamilton, Technical Superintendent, Container Corp. of America, Chicago, Ill.
"How Costly Is It to Operate Your Modern Equipment with Horse and Buggy Methods of Handling Steam?" by Paul Harrison, President, Velocity Steam Production Engineering, Inc., Chicago, Ill.
"Technical Personnel Is Expensive," by Harry J. Bettendorf, President and Editorial Director, *Fibre Containers & Paperboard Mills* Magazine, Chicago, Ill.
"The Customer Speaks," by L. H. Grubbs, Buyer, Johnson & Johnson Co., Chicago, Ill.

Component Material Requirements. Mr. Farrah outlined the characteristics of liner board and corrugating medium necessary to produce high quality boxes. He pointed out that appearance and performance are the two important qualities of shipping containers and that the component materials must have the proper characteristics so that these qualities can be achieved. Furthermore, the component materials must have the qualities that will help achieve efficient low-cost operation in the fabrication of boxes.

Chicago TAPPI Corrugating Conference, l. to r.: M. L. Hamilton, Container Corp. of America; Paul Harrison, Velocity Steam Production Engineering, Inc.; H. J. Bettendorf, Fibre Containers and Paperboard Mills; V. V. Vallandigham, Kelco Co.; G. A. Zinkil, Central Fibre Products Co.; C. A. Farrah, National Container Corp., L. H. Grubbs. Johnson & Johnson Co.; and R. T. Cassady, The Jackson Box Co.

With regard to liner board, properties that affect box *appearance* are weight, caliper, finish, odor, formation, ink receptivity, and cleanliness.

Liner board properties that affect box *performance* are weight, caliper, tearing strength, tensile strength, moisture resistance, scuff resistance, bursting or Mullen strength, puncture resistance, ring stiffness, and folding endurance.

Liner board properties that affect box *fabricating* operations are weight, caliper, tearing strength, tensile strength, moisture content, and scuff resistance.

With regard to properties and characteristics of the corrugating medium, Mr. Farrah made the following points: Appearance is not too important. Weight is prescribed by Rule 41. Caliper has little effect. Rough surface tends to give a more rigid sheet. Rigidity is the prime factor especially in its effect on performance. Uniform moisture content is most important. Tensile strength and tear strength are both necessary but bursting strength doesn't seem to be too important.

Throughout his discussion Mr. Farrah emphasized that uniformity of paperboard characteristics is the most important factor involved. He pointed out that standards for physical requirements of board must be developed as a cooperative effort between the box maker and the board manufacturer, taking into consideration all the factors necessary to achieve the end result, namely, a high quality shipping container. Qualities desired in the finished container must be built into the liner board and corrugating medium components.

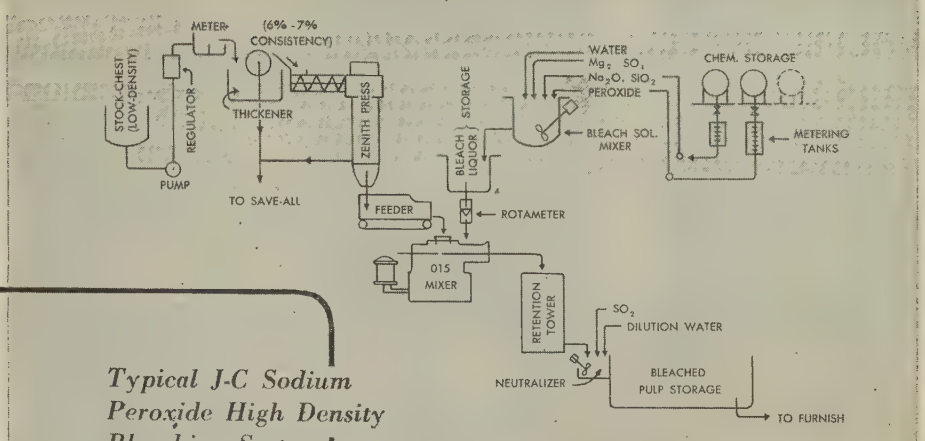
Operation of the Corrugator. In his talk, Mr. Cassady traced his own company's reputation for good operation to good equipment which is well maintained and operated by employees who know what they are doing, who wish to do a good job, and who have the confidence and respect of management. He expressed the opinion that increased technical knowledge and control are necessary. The need for more technical knowledge was obvious, he felt, from comparison of today's price of a corrugator in the hundreds of thousands of dollars, as compared with about $27,000 some 30 years ago. Speeds of 500 feet per minute today (possibly 1000 in the near future) indicate the same need, he said; in fact, companies will soon find it worth while to spend thousands of dollars just to take sheets off high-speed corrugators. Such machines, although engineered to run at high speeds, will not attain the resultant economy if the educated and trained man power isn't available.

This means that management must convey knowledge and information to personnel, so that the techniques and reasons for them are known and understood. At the same time, management must know enough about operations at the plant level to provide a practical understanding of the problems met in operation. Operating techniques which he touched upon, and which he stressed, were adequate heat, particularly at the single facer, adequate showering of component materials, glue roll parallel to corrugator roll, tight and accurate finger setting, attention to corrugator roll tooth contour, and balance moisture in the board components to prevent warping.

Quality Control in the Box Shop. In discussing this subject, Mr. Hamilton outlined the functions of quality control department as follows:

1. Meeting the requirements as defined by the shipper, the customer, and the government.
2. Improve and maintain efficient production by policing materials, policing waste, and policing quality.

Jackson and Church — HIGH DENSITY SYSTEM



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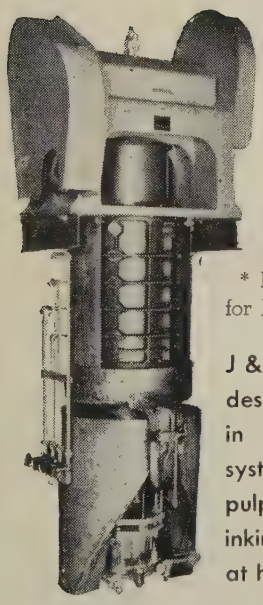
USES *NO MORE* PEROXIDE TO BLEACH *HIGHER* TONNAGE TO *SAME* BRIGHTNESS or *SAME* TONNAGE TO *HIGHER* BRIGHTNESS



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The J&C High Density System makes possible bleach consumption savings up to 25%.

HERE ARE ADDITIONAL ADVANTAGES:

- High density—40% or higher
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- Aids good housekeeping

JACKSON & CHURCH COMPANY · SAGINAW, MICHIGAN

G. A. Farrah, National Container Corp.

R. T. Cassady, The Jackson Box Co. Corp.

3. Developing answers to sales problems with regard to decorative and protective coatings, special constructions, and customer complaints.
4. Keeping abreast of new materials and equipment so that the plant may be kept at a high state of efficiency.

Mr. Hamilton pointed out that every stage of the fabricating process has its own potential hazards and that the finished box can be spoiled in process unless every effort is made to see that each operation is properly carried out. This requires a comprehensive testing program to find defects in the boxes and trace those defects back to machine adjustments, board characteristics, etc.

One of the important jobs of the quality control department is to keep up with new developments in materials, sizes, coatings, waterproofing chemicals, adhesives, inks, glue, gum tape, and other materials that go into the finished box. Only by keeping pace with developments in all these fields is it possible for a box maker to maintain progress in this competitive field.

Steam System on Corrugators. Mr. Harrison first described the concept of a steam system which his company introduced for corrugators some years ago. This turned attention to the real goal of heat actually transferred to the corrugated board, as contrasted with the apparent heat of the corrugated rolls or the double backer hot plates. This is known as the Velocity system, which takes into consideration the fact that high heat transfer demands adequate steam flow at a rate in keeping with the heat to be transferred. If the heating surface is insulated by air inherent in all water or condensate films, the flow is reduced removing more than is generally recognized. He said that gas films offer 15 times the resistance and condensate films offer 60 times the resistance as the same thickness of metal wall.

Attacking this problem was a system of speeding up the steam flow by means of a control unit. Feedwater was first deaerated as much as possible; speeded flow helped to return condensate more rapidly as well as removing air films. At the same time a pulsating action (alternation of a slightly raised and lowered steam pressure) tended to flash some condensate on heating surfaces back into steam and by turbulance to enhance the sweeping action of the stepped-up steamflow. The pulsating or unsteady flow also made use of a principle familiar in electricity that an unsteady flow permits more volume to flow through a circuit than will a steady flow. The result, he said, was greater heat transfer on existing equipment so that production rates in most instances were increased substantially.

One interesting point he made was that, initially the system did not work on certain corrugators, until it was found that other faults in the equipment made it impossible to take advantage of the increased heat transfer; thus, the point made was that improved steam utilization acted as a prod for generally improved operating techniques. He then told of recent improvements made in the process, including preheating the feedwater to 300°F.; returning condensate to the boiler at the rate of flow of the fresh steam; using techniques in fresh water feed in conjunction with any drop in boiler water level to hurry any lagging in condensate return; and interruption four times per minute by the control unit of the feedwater flow. By these and other means, he believed it was possible to make a boiler do 20% more work. In connection with the effect on corrugators, he said that, once an operator has a machine which is delivering heat rapidly and steadily to the product, he is then ready to turn to discovery of other faults in the operation which may be inhibiting a high rate of production.

Technical Personnel Is Expensive. In developing this subject, Mr. Bettendorf traced the history of the industry from the time when corrugated boxes were first used for express shipments in about 1895, and outlined the effect of the Pridham decision in 1914. He pointed out that the regular slotted container, which still represents 70 to 90% of corrugated box output, was one of the vital reasons for quick growth of the corrugated box industry. The regular slotted container fits straight-line production and has been the most economical box for most purposes. He gave a number of figures on the growth of the paperboard industry and showed how it has far outdistanced the growth of the pulp and paper industry in general.

The industry has now grown where corrugated value alone is over a billion dollars per year. The industry is now too prominent to avoid its responsibilities to customers, railroads, and the general public for safekeeping of goods in transit. Therefore, it is necessary that an intelligent technical approach be followed so that the industry might continue its dynamic growth through greater service and better products. It was shown that every technician, to be most effective, must learn to communicate with management effectively and that management must help guide the technical attack by applying its knowledge of economic, operating, and sales problems. Practically every phase of operations in the production of corrugated boxes needs to be re-examined for the purpose of developing better and more efficient and more economical methods and techniques. In conclusion it was brought out that technical personnel is expensive if it isn't properly, intelligently, and fully employed. But, when it is fully employed and is integrated with management for the best interests of the company and the industry as a whole, it is the most economical catalyst in promoting the growth and development of the industry.

The Customer Speaks. Mr. Grubbs stated that his company, Johnson & Johnson, used 2 to 3 million square feet of board per month, in the form of some 250 different types and sizes of boxes in its Chicago plant. Corrugated board ranges from nontest to 350-pound test and with A, B, and C flutes, etc. In short, the company's wide variety of packaging needs

M. L. Hamilton, Container Corp. of America

Paul Harrison, Velocity Steam Production Engineering, Inc.

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H. J. Bettendorf, Fibre Containers and Paperboard Mills

L. H. Grubbs, Johnson & Johnson Co.

are supplied by an equally wide variety of board and board products. In discussing the subject, Mr. Grubbs pointed out that the purchasing department of his company keeps in close contact with the shipping department and the claim and adjustment department to keep track of damage to products during shipping and warehousing. It doesn't matter how fine quality the product is unless it arrives at the merchant's warehouse in good condition. In general he felt that the board and cartons purchased by his company have been of satisfactory quality. He did emphasize that one of the most important qualities in cartons for his company is uniformity. He did comment on a number of points where he thought improvement might be made.

Scoring—deeper and cleaner scoring—would help make cartons square up properly and make them easier to seal.

Taping and stitching—in general, taping of cartons is satisfactory. His company utilizes palletizing as much as possible and can't use stitched joints because the double thicknesses tend to produce rocking of the cartons on the pallets, and do not produce good pallet loads. Furthermore, staples and stitching tend to scratch the product package. Mr. Grubbs wondered whether a plastic staple might not be developed for this purpose.

Design—in general the design of packaging is satisfactory. Mr. Grubbs felt that the customer should not try to design the boxes but should cooperate with the box manufacturer in this effort.

Printing—printing matter on cartons is important for two reasons: namely, advertising value and product identification. From the standpoint of advertising value he pointed out that his company turns out the best quality of products possible. It is only consistent that they want to have a good, well-printed carton in which to ship these products. Therefore, they want the printing matter on the outside of the carton to reflect the quality of the products inside. From the standpoint of product identification it is also necessary to have good printing that stands out well. Most warehouses are relatively dark and it is also dark and dingy in trucks and box cars. Errors frequently occur when it is hard for a workman to identify the product. Therefore, good, bold, heavy printing is necessary and desirable to prevent errors in shipping, bills of lading, etc.

He spoke of the difficulty in obtaining good, heavy printing on the large display type on cartons without the finer print filling in. He emphasized that the display printing was the most important and suggested that the finer print be made larger so that a uniform readable print job will be obtained.

Johnson & Johnson's packaging applications fall into the following general classifications: tinware, including first aid kits; glassware, including bottles and jars of lotion, creams, etc.; compressible products in individual packages; compressible products in bulk. The first three classifications all give support to the shipping containers in which they are packed, and little trouble develops in the packaging of these types of items.

However, in the last classification of compressible products in bulk, the company has had some definite problems. Here, the boxes are filled over full and compressed down and the box sealed. In a few days' time the material loses some of its fluffiness and shrinks to where it doesn't fill the box. Therefore, when the boxes are stacked on pallets the box walls must support the total weight of the load above. Even though the boxes are made of 200-pound test board, the pallet loads can only be stacked two tiers high since if stacked higher the stacks will topple over. Since storage space is at a premium and there is actually enough head room for higher stacking, there is an actual loss of nearly half of the storage capacity of the warehouse on this product. Obvious answers of higher test board, added pads, lines, etc., are not possible due to management orders that cost not be increased. According to Mr. Grubbs, the above problem is typical of those frequently faced by users of boxes and the box manufacturer has an opportunity to render real service in the solution of such problems.

Pacific

The Pacific Section met at Olympia, Wash., on Jan. 15, 1952, at the Olympian Hotel. Arrangements for this meeting, which was attended by approximately 175 members, were made by John W. Bennet, Rayonier, Inc., Shelton, Wash.

The technical meeting, as usual, was held at 2:00 p.m. and was followed by a reception and dinner at the Hotel Olympian. Virgil Sutherling, Engineering Div., Longview Fibre Co., Longview, Wash., acted as moderator for the technical session at which the subject of "Process Control" was discussed by a panel of four speakers.

The dinner speaker, Art Anderson, President of the Everett, Wash., Chamber of Commerce, and posing as Dr. Axel Soderblum of Karlstad, Sweden, provided a delightful hoax for the uninitiated along with many a chuckle from his friends in the pulp and paper industry.

A résumé of the papers presented at the afternoon meeting follows:

1. "Instruments Are Cost-Cutters," by J. K. Gould, Instrument Supervisor, Longview Fibre Co., Longview, Wash.

The prosperity and security of this country depends on the efficient production of American industry. This efficiency of production is possible only through use of better tools, machinery, and instruments.

Instruments cut costs by reducing labor costs, by elimination of human error, by fuel and electric energy savings, material savings, increasing production from existing equipment; by giving better quality of product and minimizing rejects; by aiding in converting batch processes to continuous processes, with resultant savings in space required for process equipment; and by shortening the training period for new employees.

Instruments properly selected, properly installed, properly used and maintained will pay for themselves in a reasonable length of time. They represent only a small part, from 1 to 5% of total plant investment depending on the type of industry.

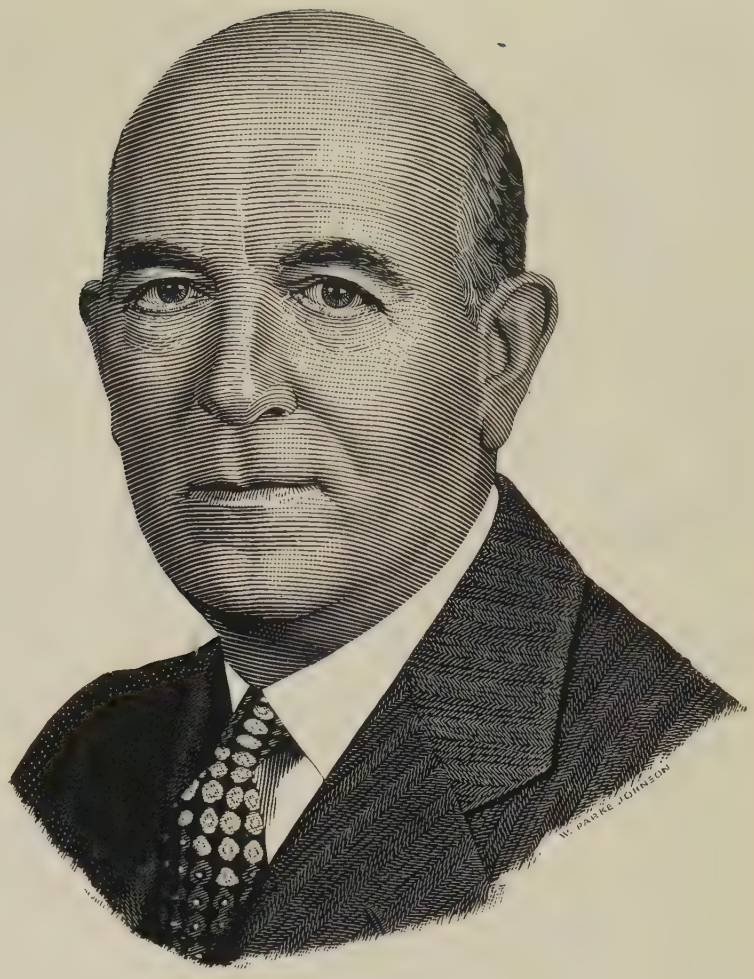
Too much emphasis cannot be placed on proper selection of instruments to fit the process. No haphazard conglomeration of odds and ends can possibly give as efficient results as a properly engineered installation designed by competent applications engineers. Of equal importance is adequate maintenance by properly trained instrument mechanics.

With today's high labor and material costs, instruments are the best answer to industry's number one problem of increasing production and cutting costs.

2. "Automatic Firing of Hog Fuel," by C. H. Carter, Puget Sound Pulp & Timber Co., Bellingham, Wash.

This installation of equipment was made for the promotion

". . . helping to keep the business cycle on an even keel . . ."



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- and as Mr. Higgins points out, the systematic purchase of Defense Bonds through the Payroll Savings Plan is building a tremendous reserve of purchasing power.

Let's point up the third employer benefit with a few figures:

- On September 30, 1951, individuals held Series E Bonds totaling $34.6 Billion—more than $4.6 greater than on V-J Day.
- During the five calendar years (1946-1950) Defense Bonds sales provided:

—*Cash* to retire $3 Billion A-D Savings Bonds (maturing Series).

—*Cash* to meet $24 Billion redemptions of E, F and G Bonds.

—$6 Billion (after providing cash for the payments enumerated above) that the U.S. Treasury could use to pay off bank-held debt.

And the figures are getting better every day—between January 1, 1951 and November 1, 1951, 1,200,000 employed men and women joined the Payroll Savings Plan.

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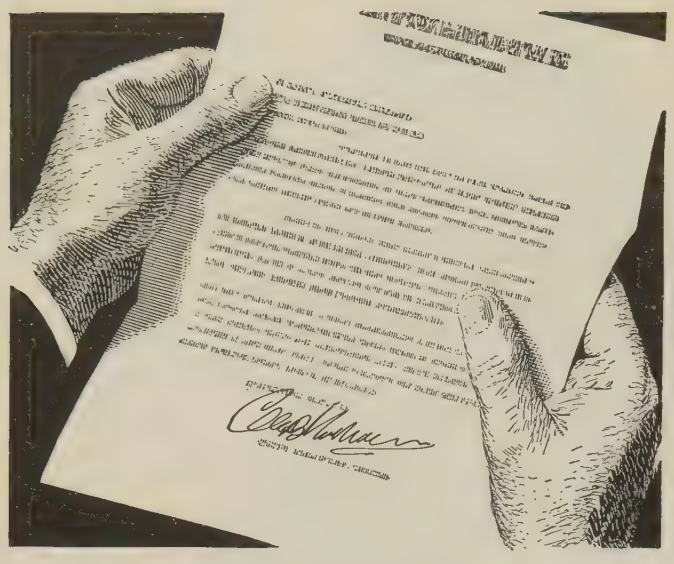

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Many mills in every part of the country have tried Butterworth Calender Rolls and now use them exclusively. Experience in actual service proved Butterworth Rolls produce a uniform, quality finish with savings in operating costs.

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of greater economy and efficiency of steam power; because the reduced supply of hog fuel, and the change in its moisture content and texture, made some innovation necessary.

Prior to our development of this installation, there had been no accomplishment along these lines from which we could pattern.

So far as we know, we have the only installation whereby hog fuel can be fired automatically simultaneously with the automatic firing of oil; either of the fuels being used as the major fuel, with the other used as an auxiliary fuel.

Through this operation, we have made a net increase of boiler efficiency of up to 0.08%.

3. "Graphic Panel Instrumentation," by R. D. Irwin, Minneapolis-Honeywell Regulator Co., Brown Instrument Div., Philadelphia, Pa.

Out of the recent expansion in instrumentation has come the graphic panel—the talk of engineers for the past decade but now here to stay. The use of these panels has been accelerated by the rapid expansion of industry and the need for fast training of new operating personnel.

The graphic panel presents to the operator a panoramic view of the complete process under control. This helps the experienced, as well as the inexperienced, operator because there is a complete view of the process in front of him at all times. The graphic panel is most useful for continuous processes such as the brown stock washers or bleach plant. The use of graphic panels on batch processes is questionable but under some conditions may be desirable.

The addition of the graphic diagram to the panel complicates its construction and consequently increases the cost. This additional investment can frequently be justified by:

1. The reduced time required to train personnel.
2. The lower cost of housing the smaller graphic panel instead of the conventional panel.

To date, there is no hard and fast rule that can be used to definitely select either the graphic or the conventional panel for a particular installation. These are some of the questions that should be asked and properly answered in your analysis to determine which is best for your application:

1. Is the process continuous?
2. Does it use interrelated pieces of equipment?
3. Is training new personnel a significant factor?
4. Is housing adequate for a conventional panel?
5. If not, could the space saving of a graphic equalize the overall cost?

4. "Radioisotopic Tracers in Industry," by Dr. J. H. Rediske, Nucleonics Dept., General Electric Co., Richland, Wash.

A discussion is presented of the characteristics of radioactive isotopes which make their use in industry practical. Examples of chemical and physical tracing already in use in the rayon and oil industries are considered with possible applications to the pulp and paper industry. Several instruments are discussed which employ radioactive isotopes in such a manner that they are not incorporated in process material. These instruments are the Penetron, back-scattering thickness gage, float-type liquid level indicator, area measuring device, and the thickness gage. R. M. TRUE, *Secretary*

Lake Erie

The Lake Erie Section met at the Hickory Grill in Cleveland, Ohio, at 8:15 p.m. on November 16 to discuss the subject of training programs. About 43 were in attendance with William Hasselo of the Container Corp. of America presiding as chairman. The principal speakers were William Grier of the Industrial Rayon Corp., Painesville, Ohio. Mr. Grier is a member of the Training Directors' Association, (Ohio Section) and Stewart Drum, Superintendent of the Corrugating Div., Container Corp. of America, Cleveland, Ohio. Mr. Drum is a member of the Training Directors' Association, Illinois Section.

Stewart Drum, Container Corp. of America; William Grier, Industrial Rayon Corp.; K. P. Geohegan, Howard Paper Mills Inc.; and William Hasselo, Container Corp. of America

Mr. Drum's topic was "Does a Training Program Pay?" In the introduction, Mr. Drum proposed several related questions such as:

What is training?
Who is responsible for training?
Who should do the training?
What training should exist in your plant?
How can it be accomplished?

Mr. Drum incorporated the introductory questions into the theme of his talk, pointing out that management is the development of people rather than the direction of things. In every organization learning takes place—good or bad—directed or undirected. If we think of the functions of an executive as selection, education, and coordination, we come to realize that unless learning is directed and good, the executive is failing in an area of vital importance.

The aim of education and training in an industrial organization should be to build continuously and systematically to the maximum degree and in the proper proportion, that knowledge and those skills and attitudes which will contribute most to the welfare of the company, the employee, the customer, and the community. It should close the gap between people's potential and their actual achievement.

No company can be better than the collective abilities of its total personnel. While top producers have been developed within companies throughout the country, not enough emphasis has been placed on improving the productivity of all members of the organization. Of course, all companies wish to accomplish this and to have more top producers but in the minds of many people there is still an air of mystery about how it is accomplished. They think a person's success is perhaps the result of individual differences or tremendous initiative or native intelligence or luck. Actually a man's success more often depends upon the guidance of one of his former bosses who was a good teacher, interested in his growth and advancement, and capable of motivating and directing him toward developing his abilities and skills.

Today, in industry, there is not a shortage of potential leaders and administrators, but there is a shortage of those who are capable of creating an environment in which executive development can take place. It is absolutely necessary for the future success of any organization that everyone in the management group accepts and executes the responsibility he has for sponsoring and improving the process of personnel development of his subordinates.

We who work in relatively small plants can place almost insurmountable barriers before ourselves if we would rather make excuses than show results. It is easy to trap ourselves into thinking there are disadvantages in working in a plant without a training department. And we think we can justify

At all points in the mill where hand oiling is necessary, frequent oilings with ordinary lube oils are your only assurance of getting lubrication that is "always there" where it's needed. But if you use a lube oil that really adheres to the metal of your bearing surfaces, you won't have to oil as often.

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Magnus Kling-Oil is a tacky, mobile fluid with an SAE viscosity of 30. It clings tenaciously to bearing surfaces. It insures perfect lubrication . . . and greatly reduces the number of oilings required to maintain it. It does not wash off exposed journals even when subjected to water spray.

Watch the Amps Drop!

While you're saving labor on the oiling operation, the consistently superior lubrication insured by the way Kling-Oil stays put will definitely reduce the power required for the machines. This is particularly true of the press section and similar "power eaters" in the mill.

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Down through the years, many new techniques of Bauer fiber processing have been learned in actual mill practice and in laboratory runs on commercial-size disk refiners. Along with these developments, continuous improvements have been made in the machines themselves.

Today, Bauer Disk Refiners are processing almost all conceivable kinds of fibrous materials—hard and soft woods, screen rejects, sheet pulp, rags, roots, straw, waste paper. The end products range from bond papers to wall board and roofing felts.

Whatever your fiber processing or stock preparation problem, chances are that we can refer you to operations where Bauer Refiners are doing similar jobs. If not, we'll be glad to make tests for you in the Fiber Products Laboratory on our premises.

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the absence of training in our own area of responsibility by thinking we work for men who are not too interested in training. The labor market may be tight. We may think we have marginal workers and low starting rates and perhaps an unenlightened union. We may also believe our company, our plant, and our work differs from those companies which have successful training programs. These problems whether they be real or imaginary will be eliminated or yield to solution if we in management use the intelligence we have and develop in ourselves and in our subordinates a high degree of emotional and social maturity.

Mr. Drum then described the approach to training and education which he had been using and summarized the results.

Actually the best training program can be established in a relatively small plant in which the Production Manager assumes full responsibility for education and training. He and the Personnel Manager should become Training Directors through study and self improvement and all foremen and other management men should become teachers. Everyone must be alert to spot training needs and specific programs must be established to take care of each need. The programs which are carried on in larger plants and seem bigger and better are really a substitute for the more direct and ideal method of each member of management motivating, training, and developing those people under his direction. In the smaller plant communications can be better and closer relationships more easily established.

Taking a final look at our subject, "Does a Training Program Pay?" Mr. Drum said that he was sure that where it is sincerely approached, intelligently administered, and accurately measured, it can prove a great pay-out in dollars and cents as well as in psychic income to your management and employees. But even more important now is the fact that training and education in industry are absolutely necessary to preserve democracy. The "Free Enterprise System" can stand the light of truth. We must meet the challenge of Socialism and Communism and prove to the American workers that the "American Way of Life" is giving them greater rewards and opportunities than they could receive under any other system. Industry must assume the full responsibility of a social organization. It must contribute to the enlightenment of our people to provide them with the understanding necessary to exercise intelligent judgment. Unless we prove to our workers that the "Free Enterprise System" can outperform communism, socialism, or any other controlled economy, the failure of democracy is assured.

There is more than dollars in the balance today—so when *you* answer the question "Does Training *Really* Pay" be sure you know the price you place on freedom.

Dr. Drum's presentation was followed by a similar discussion by Mr. Grier who discussed his experiences over the past ten years in training people. Mr. Grier gave several examples where training had shown definite savings in producing more with less people.

Following the talks, a general discussion period took place. Many of the questions had the same general theme, such as the economics of a training program and where aid could be obtained in carrying out a training program. Agencies where aid may be obtained were stated as the local Department of Labor offices and State Industrial Education organizations. Mr. Grier outlined the organization of the Training Directors' Association which has sections in the principal states and has equipment and training plans available for the use of those people desiring aid.

The Section was pleased to welcome Ken Geohegan, President of TAPPI, as a visitor who spoke to the group briefly and commended them on their progress over the past two years. Mr. Geohegan also called attention to the meeting of the Ohio Section of TAPPI on December 11 in Columbus, Ohio.

A dinner meeting and a talk on static electricity and

J. H. Thompson, Minerva Wax Paper Co.; William Hasselo, Container Corp. of America; and T. M. Hill and Mr. Sweet, Aluminum Co. of America

printing preceded by tours of the Battelle Memorial Institute and the Pollock Paper Co. were planned.

The annual Christmas Party on December 21 was also called to the attention of the members attending.

It was also announced that Thomas M. Hill, Technical Adviser of the Aluminum Co. of America in Pittsburgh, would cover the packaging field with special emphasis on the present types of food packaging. It was also announced that Dr. Hill plans to discuss government specifications and what is required to meet them.

R. L. Lewis, *Publicity Chairman*

Meeting of Jan. 18, 1952

The Lake Erie Section met at 8:15 p.m. on January 18 at the Hickory Grill in Cleveland, Ohio. William Hasselo, Container Corp. of America, presided and Joseph H. Thompson, Minerva Wax Paper Co., Program Chairman, introduced the speaker. Thomas M. Hill, Technical Adviser, Aluminum Co. of America, Pittsburgh, Pa., gave an interesting paper on "Aluminum Foil in Protective Packaging."

Before the meeting was adjourned, Mr. Hasselo announced that the subject for the February 12 meeting was "Cashing in on a Suggestion System." The speakers were Joe Harwood, Morton Suggestion Systems, Cleveland, Ohio, and Mel Goffinet, Industrial Engineer, Ohio Boxboard Co., Rittman, Ohio.

Dr. Hill's paper follows:

Aluminum Foil

Thomas M. Hill

Aluminum foil was first produced in commercial quantities in the United States before World War I by Aluminum Co. of America. Today it is the most available, most economical and commonly used metal foil. Foil may be defined as thin metal sheet less than six one thousandths of an inch (0.006 inch). Thicker than metal leaf, commercial foil is usually produced in the range between 0.00035 and 0.005 inch, but slightly thicker and thinner foils may be made to meet special requirements. Alcoa foil is available in widths slightly over 50 inch.

Alcoa aluminum foil is a product of commercially pure aluminum. The metal is obtained by the electrolytic reduction of aluminum oxide (alumina), dissolved in a bath of molten cryolite. Pig aluminum from the reduction operation is remelted and cast into ingots for subsequent rolling operations.

Thomas M. Hill, Technical Adviser, Aluminum Co. of America, Pittsburgh, Pa.

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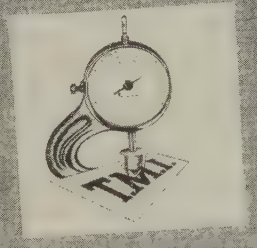

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First the ingot is reduced to slab by hot rolling and then it is cold rolled into coiled sheet suitable for continued rolling on foil mills. Annealing of the strain-hardened metal and an occasional edge trimming are interspersed from initial breakdown passes to the finished foil gage. Softened metal and smooth edges are essential for the production of thin foil of uniform thickness and quality. A precise control of lubricant, roll shape, pressure, speed, and temperature for rolls is also essential for the production of foil conforming to commercial standards for thickness, brightness, and freedom from irregularities.

The finished rolled-to-gage foil is in the hard (H-19) temper, characteristic of aluminum after extensive cold working. Foil, as a rule, is annealed immediately prior to final inspection, packing, and shipping because it is more generally used in the softened condition. Annealed or soft foil is identified as "O" temper.*

Alcoa aluminum foil is a product of commericially pure (2S) aluminum with a minimum aluminum content of 99.0%. A normal foil composition is about 99.5% aluminum but may vary from about 99.45 to 99.6%. The approximate 0.5% of other elements in commercially pure foil are predominantly iron and silicon and contribute to the strength of the product.

Foil for special purposes is produced on demand from high purity metal having an aluminum content of 99.8% plus. It is identified as 99.8% aluminum foil. Some stronger and heat-treatable aluminum alloy compositions are rolled into foil thicknesses. Distinctive characteristics are associated with a specific chemical composition, thickness, or temper. However, the preponderance of oil is made from commercially pure aluminum and justifies the limitation of data in this article to that product.

Physical Properties

Typical physical properties for Alcoa's 2S alloy in the "O" annealed temper are summarized in Table I.

Table I. Typical Physical Properties 2S-O Aluminum

Specific gravity	2.71
Weight, per lb. per cu. in.	0.098
Approximate melting range, °F.	1190–1215
Electrical conductivity % of International Annealed Copper Standard	59
Thermal conductivity at 25°C., c.g.s. units	0.53
Average coefficient thermal expansion per degree F. from 68 to 212°F.	13.1×10^{-6}
Reflectivity for white light, %[a]	85–88
Reflectivity for radiant heat from source at 100°F. (approx.), %	95
Emissivity of radiant heat at 100°F. (approx.), %	5

[a] Values are typical for plain, bright aluminum foil. A cleaned surface of high purity aluminum may reach 90%. (Light from tungsten filament lamp.)

Thickness, Gage, Covering Area

The high covering area per unit of weight is one of aluminum foil's important characteristics. It is directly associated with the low density of the aluminum (specific gravity 2.71). Covering area data are based on a weight of 0.0975 pound per cubic inch for commercially pure aluminum which is equivalent to 10,250 square inches for one pound of foil 0.001 inch thick. Covering area values for other thicknesses may be readily calculated.

Foil producers in the United States express thickness in thousandths of an inch and covering area in square inches per pound. European producers use the metric system. In some uses of foil it is convenient to consider area units in

* "O" is the temper identification for annealed metal which has undergone recrystallization by heat; "H-19" is the temper identification for strain hardening effected by cold working during fabrication where it is in excess of the strain or cold working normally used to produce the hard temper (H-18) after annealing. Annealing is effected by heating at temperatures above 650°F. This operation softens the foil, removes traces of lubricants left from rolling and, incidentally, sterilizes the foil.

terms of square feet per pound or on a basis of one of several reams common to branches of the paper industry. Table II has been prepared to show the covering area in square inches per pound from 0.00025 to 0.005 inch thick in steps of one half of one thousandth of an inch (0.0005 inch). These data have been used to calculate the approximate corresponding values for square feet per pound and the pounds in a ream for three designated reams.

Table II. Foil Thickness Covering Areas and Pounds per Ream

Thickness, in.	*Sq. in. per lb.*	*Sq. ft. per lb.*	*Pounds per ream, 414,720 sq. in.*	*Pounds per ream, 432,000 sq. in.*	*Pounds per ream, 260,000 sq. in.*
0.00025	41,000	285	10.14	10.54	6.36
0.003	34,100	237	12.17	12.67	7.63
0.00035	29,200	203	14.20	14.79	8.90
0.0004	25,600	178	16.22	16.87	10.17
0.00045	22,700	158	18.25	19.03	11.44
0.0005	20,500	143	20.28	21.07	12.52
0.00055	18,650	129	22.31	23.16	13.99
0.0006	17,000	118	24.34	25.41	15.27
0.00065	15,700	109	26.36	27.52	16.53
0.0007	14,600	102	28.39	29.59	17.80
0.00075	13,670	94.9	30.34	31.58	19.02
0.0008	12,800	89	32.45	33.75	20.35
0.00085	11,790	81.9	35.18	36.59	22.06
0.0009	11,390	79	36.50	37.92	22.89
0.00095	10,760	74.7	38.54	39.98	24.16
0.001	10,250	71	40.56	42.15	25.43
0.0015	6,800	47.2	60.84	63.27	38.15
0.002	5,100	35	81.12	84.70	50.86
0.0025	4,100	28.4	101.40	105.46	63.58
0.003	3,400	23	121.68	127.06	76.29
0.0035	2,930	20.3	141.96	147.64	89.01
0.004	2,550	18	162.24	164.11	101.72
0.0045	2,270	15.7	182.52	193.82	114.44
0.005	2,050	14	202.80	210.73	127.16

(1) Ream 480 sheets 24 × 36 inches equals 414,720 sq. in. (2) Ream 500 sheets 24 × 36 inches equals 432,000 sq. in. (3) Ream 500 sheets 20 × 26 inches equals 260,000 sq. in. (4) Ream (1) 414,720 sq. in. multiplied by the factor 1.041 equals ream (2) or 432,000 sq. in. (5) Ream (1) 414,720 sq. in. multiplied by the factor 0.627 equals ream (3) or 260,000 sq. in.

Mechanical Properties

Mechanical properties of aluminum foil which are of interest include tensile strength, per cent elongation, and values for resistance to bursting and tearing. These values are not required to control foil production operations. They are, however, becoming more important when selecting materials for government packaging specifications where mechanical property limits are required.

The mechanical property values increase with increases in foil thickness except for per cent elongation values for strain-hardened foils. Also, tensile strength and values for resistance to tearing and bursting for strain-hardened foils are greater than the values for identical foil thicknesses in an annealed condition. The percentage elongation values are lower for foils in the strain-hardened condition.

Chemical Properties

Aluminum's characteristic formation of a protective oxide film is of importance in its applications. Aluminum foil has good resistance to atmospheric attack and resists corrosion by many materials so that it has a wide range of applications as a packaging material. The metal is nontoxic. Its compounds are colorless and, therefore, usually not objectionable when small quantities are formed as a result of mild chemical attack. Its resistance to attack is the same as that of commerical pure aluminum, but an action which may be relatively insignificant on thicker sections can become a factor in the appearance and properties of bright, thin foils.

Experience and test have developed a rough guide for the expected action of some chemicals on aluminum. However, there are innumerable substances that might come in contact with aluminum, as well as a variety of exposure conditions

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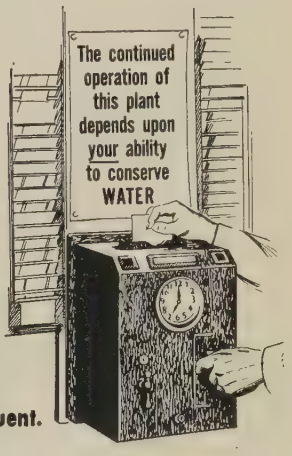

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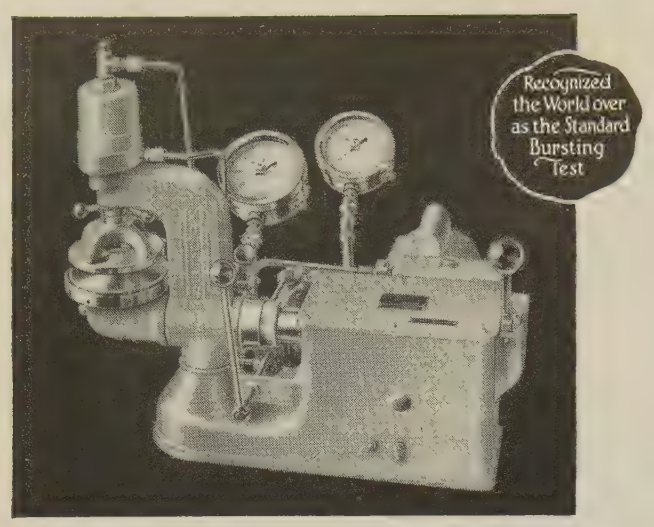

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such as temperature, concentration, dryness, purity, or galvanic action resulting from contact with dissimilar metals which make general statements or unqualified lists of corrosive or noncorrosive agents for aluminum uncertain. Some examples, however, may be cited to indicate the expected action of chemicals which are almost certain to be corrosive and other chemicals and conditions which are practically noncorrosive.

Caustics—Alkalies

Strong caustic agents such as sodium, potassium, or barium hydroxides will corrode aluminum severely. The weaker alkaline agents such as calcium and ammonium hydroxides are less active, but are generally corrosive, depending on conditions.

Acids

Strong acids such as hydrochloric, hydrobromic, and hydrofluoric are among the more severely corrosive acid agents. Nitric acid above 80% and fuming sulphuric acid are less corrosive than their diluted solutions. Similarly diluted acetic acid is more reactive than glacial acetic acid or acetic anhydride.

Acids such as benzoic, boric, carbolic, carbonic, chromic, gluconic, citric, maleic, malic, and the fatty acids are less active or inactive toward aluminum and may, under satisfactory conditions, be used in contact with it.

Salts and Esters

Salts and esters vary widely in their action with aluminum, depending on composition and condition. Compounds which may be used dry in contact with aluminum, but which hydrolyze in the presence of water to form relatively strong acid or basic solutions, can corrode aluminum severely. Conversely, some salts tend to offer protection by inhibiting corrosion. Solutions of potassium carbonate and potassium cyanide may corrode aluminum whereas sodium or potassium silicate and chromate, dichromate, nitrate, and sulphate may be used in contact with aluminum.

Oils

Vegetable, animal, and mineral oils are not expected to be reactive toward aluminum. Aluminum foil is considered a good barrier to oil transmission.

Solvents

Many organic solvents such as neutral esters, ethers, paraffins, and aromatic hydrocarbons are not expected to corrode aluminum. Lower alcohols, chlorinated and amino compounds in the presence of water will corrode aluminum to some extent.

Food Products

In general, foods such as candies, milk, unsalted meats, butter, and oleomargarine are not corrosive to aluminum. Salted products, including many cheeses, will corrode aluminum.

Illustrations indicating the effect of conditions are evident from the expectation that aluminum in contact with wet cork will corrode and will not when dry. Similarly, boiling chloroform is expected to corrode aluminum whereas no action is expected at room temperature.

Weathering

The resistance of aluminum foil to weathering is similar to that of Alcoa's 2S-0 sheet. Thin foils show failure by perforation; their resistance to attack increases with increasing thickness. Foil 0.001 inch thick shows numerous small holes after six months' seacoast exposure. Only a few pinholes were found in foil 0.002 inch thick, subjected to similar exposure conditions, and thicker foils were essentially free of

pinholes. Exposures of plain foils for nine months in an industrial atmosphere developed only a few pinholes in 0.001-inch thick foil; thicker foils were essentially free of holes. A salt spray test with a 20% sodium chloride spray at 95°F. developed several pinholes in foil 0.001 inch thick after 96 hours. At this time no holes were observed in thicker foils. The daily test cycle consisted of 16 hours' exposure to salt spray and 8 hours' drying at room temperature. A minimum foil thickness of 0.004 inch is suggested for consideration where prolonged outdoor exposures are expected.

Packaging Characteristics

Aluminum foil finds a wide variety of uses in packaging. Important technical characteristics which recommend it for these applications may be summarized as follows:

1. Impervious to moisture and gases (in certain gages).
2. Greaseproof.
3. Nonsorptive.
4. Shrinkproof.
5. Odorless and tasteless.
6. Hygienic, nontoxic, and sterile.
7. Resistant to corrosion; nonaging.
8. Dead folding.
9. Strong.
10. Appearance; brightness and glitter.
11. Reflects radiant heat; opaque to light.

Aluminum foil's characteristics are unique among flexible packaging materials. They include both exceptionally good functional and decorative properties. Individual wraps of aluminum foil are used in many packages, but thin foils are more often found as a component part of a laminated structure. Foil thickness is selected to supply required individual characteristics at the most economic covering area level. Annealed aluminum foil's good functional and decorative characteristics are utilized to advantage and in some instances enhanced by conversion operations. Foil may be lacquered, printed, embossed, and combined with the commercially available papers and transparent plastic films to produce a wide range of decorative and functional wrappers. It can be printed by any of the accepted commercial procedures—typographic, planographic, and gravure. The order of conversion operations, where more than one is required, is selected to produce highest operating efficiency and quality in the converted sheets. Similar criteria are used in choosing a preferred method for printing. Thinner foils are combined with the accompanying flexible paper or plastic sheet prior to printing. The laminated sheet offers more cushion and better handling characteristics for printing. Fast drying liquid inks applied by rubber plates or intaglio cut metal rolls are more commonly used in the printing of coiled foils. Typographic or letter press printing is used with thicker plain foils or supported thin sheets. Letter press oil inks require special consideration to secure proper drying. Thin wash or primer coats of resinous materials that adhere well to aluminum and are compatible with a selected ink are used with aluminum foil to improve ink adherence, increase resistance to water, or satisfy other special requirements. Shellac and vinyl resins are typical of the applicable resins.

Lacquered aluminum foils have broadened the usefulness and acceptability of foils in packaging. All-over and design-lacquered foils in a wide variety of colors and designs are available for decorative wrappers. Clear-lacquered foils offer improved resistance to staining or chemical attack. The increased protection to the metal permits a wider variety of products to be packaged in contact with a foil wrapper or liner. Foils coated with or combined with a thermoplastic film have opened a new area for foils in the packaging field. The thermoplastic coating offers protection to the foil's surface where it is required but it is most effective in promoting a sealing medium for producing hermetically sealed packages

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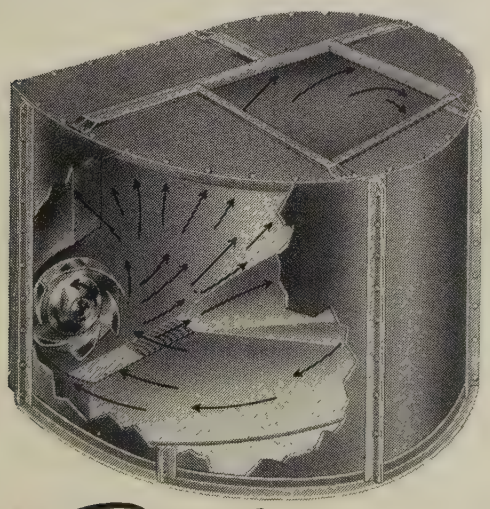

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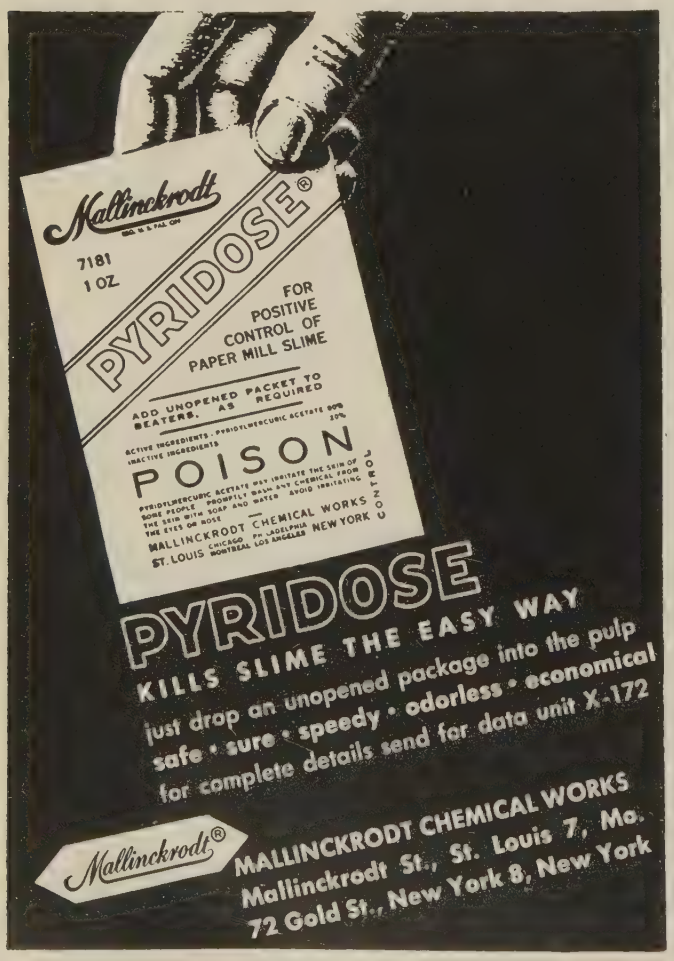
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Aluminum foils 0.001-inch thick and thinner are used to a great extent in decorative and protective flexible wraps. Alcoa foils in this range of thickness are produced by pack rolling. This operation involves doubling two sheets and reducing their gage simultaneously by a suitable rolling procedure. In addition to other desirable features, this practice produces a foil with a bright, glittery outside surface and a soft "satin" inside finish. These distinctive surfaces double the opportunity for decorative effects. The "satin" finish is preferred for many label end wrapper designs where the highly light-diffusing surface is an advantage.

Thin foils are more economical for packaging because of their greater surface area per pound. Foils 0.001-inch thick and thinner are, therefore, in great demand for their functional contributions to protective packaging. Aluminum foil in suitable gage is the outstanding flexible barrier to water vapor and fixed gases. Its resistance to penetration by water vapor increases with thickness because small "pinholes" are of more frequent occurrence in the thinner foils.

An idea of the variation in pinholes with foil thickness is illustrated in Table III. The data were obtained from a careful inspection of 100 sheets of each gage selected at random from commercial production.

Table III. Typical Variation of Pinholes with Gage

Gage of foil, in.	*Number of 12-inch square sheets with pinholes*	*Number of sheets with no pinholes*
0.00035	100	None
0.0005	100	None
0.0007	15	85
0.001	8	92

The permeability or protective characteristics of different specimens of foils may be illustrated by their resistance to water vapor transmission. Every tenth sheet of the 100 specimens inspected for pinholes was selected for water vapor transmission tests. The data obtained from these tests are shown in Table IV.

Even though there seem to be numerous pinholes in a piece of thin aluminum foil, their sizes are generally so small that the rate of water vapor transmission is negligible for many purposes. For example, in a typical sheet of aluminum foil 0.0004 inch in thickness, 80% of the pinholes had individual areas of less than 5×10^{-8} square inches. Calling these minute perforations "pinholes" may be misleading, for if the foil was punctured with the shift of a small pin, the hole made in this manner would have an area about 30 times larger than the combined area of all the pinholes in 100 square inches of this 0.0004-inch foil. Furthermore, the total effect of all the pinholes, large and small, was to give the foil a water vapor transmission of only 0.2 gram per 24 hours per 100 square inches of foil under standard test conditions.

In many practical packaging applications the effect of pinholes is negligible. To meet severe requirements, the water vapor transmission may be further reduced by lacquer coating or lamination with plastic films. Six samples of 0.00035-inch soft foil, bonded on one side to No. 300 M.S.A.T. cellophane with a lacquer-type adhesive and coated on the other side with a resinous-type lacquer, showed no measurable moisture vapor transmission in 24 hours at 100°F. and 100% relative humidity. The same observation was made with six samples of 0.0005-inch foil and six samples of 0.0007-inch foil similarly coated and combined. This result would be anticipated since the water vapor transmission for cel-

Table IV. Water Vapor Transmission of Thin Aluminum Foils[a]

Thickness of foil, in.		*Water vapor transmission, g. water per 100 sq. in. per 24 hr. with air at 100°F. and 100% R. H.*
0.00035		0.62
		0.11
		0.20
		0.23
		0.15
		0.69
		0.29
		0.34
		0.18
		0.07
	Average	0.29
0.0005		0.08
		0.05
		0.06
		0.12
		0.15
		0.09
		0.13
		0.31
		0.17
		0.04
	Average	0.12
0.0007		0.07[b]
		0.08
		0.06
		0.05
		0.04
		0.08
		0.01
		0.04
0.001		0.02[b]
		0.03
		0.02

[a] Water vapor transmission determined by General Foods-Southwick method.
[b] Water vapor transmission values not averaged because majority of 100 sheets examined had zero permeability.

lophane is only about 0.3 gram per 100 square inches per 24 hours.

Thicker foils are desirable in packaging where high protection is required for articles with a low critical range for water content and a relatively long durable life is expected. Effervescent medicinal tablets in heat-sealed packets are good illustrations. Thicker foils offer greater protection against fracture and freedom from pinholes.

Typical Aluminum Foil Applications in Packaging

Aluminum foil in a suitable gage, as might be expected from its properties, is used alone in protective and decorative wrappers, package closures, and in sealed metal pouches and packets. Seals are made with thermoplastic adhesive or lacquer formulations. Thinner foils combined with suitable paper, thermoplastic film, or sandwiched between other wrapping materials are used for packaging work in much the same way as plan foils. The selection and production of economic wraps and containers to meet specific packaging requirements are facilitated by the cooperative efforts of material producers, converters, and packers.

Illustrative applications of aluminum foil in packaging are found in plain foils for candy bars, yeast, bouillon cubes, kitchen and frozen food locker wraps, milk bottle hoods, and cottage cheese closures. Plain foils are also used for bon bon cups, wraps for chocolates, toffee, and other candies. The foil is both protective and decorative. Plain foils today are used for water vapor, grease, and oil barriers in packaging of metal parts both for industrial and National Defense requirements. Foil wraps are used for protecting surgical and precision instruments, special equipment, metal parts, bearings, and stock replacements.

Paper-backed foils are used in packages for chewing gum, hard candy, and cigarettes and for pipe tobacco packs, bags for tea, potato chips, prepared food mixes, dried milk and pre-

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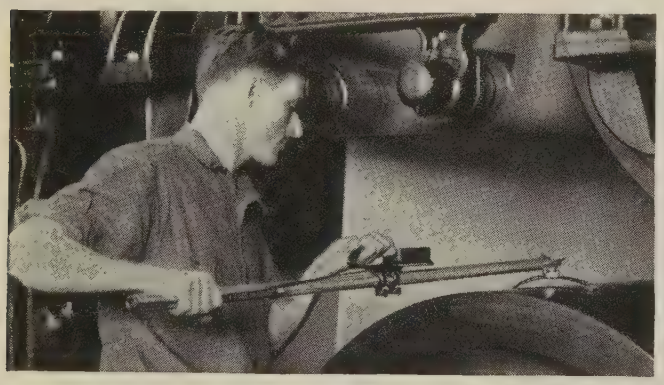

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L. E. Rolig, *Secretary*

Lake States

The third meeting of the Lake States Section was held at the Conway Hotel in Appleton, Wis., on Tuesday evening, January 8. Although driving conditions were hazardous on this day, about 160 people were present, which was considered to be a tribute to the speaker and the program.

The meeting was called to order by Chairman A. P. Adrian. Dr. Adrian announced the distribution of letters to mill managers in the area asking them to name one individual to contact regarding TAPPI routine control data sheets. The letters were prepared by Vice-Chairman H. W. Rowe.

Carl Swartz, Sales Engineer, and E. S. Skinner, Assistant Chief Engineer of the Beloit Iron Works, Beloit, Wis., were introduced by Dr. Adrian. Mr. Swartz talked on "Some Interesting Paper Machinery Developments." His topic was divided into three parts as follows:

(*1*) *Flow Boxes.* He described experimental work with small flow boxes that were foreshortened in width only, and showed with the help of sketches the development of a versatile closed flow box that could be operated either under pressure or vacuum to meet various operating conditions. Stock from the screens enters the box (*a*) through a collector box and through a series of valves, or (*b*) through a cross-flow distributor in which the stock enters from each side through two sections divided by a mid-feather. One of the important features is the control of level at a predetermined point by the use of a small hole in the side wall of the box at a predetermined level. Air is delivered to the closed chamber above the liquid and control depends on the bleed-off of air or liquid at this hole as the hole is automatically sealed or partially sealed with stock. Simply stated, control is based

on the principle that more air than water will pass through this hole. After the operating level in the box was established, experiments with baffles or other devices showed that driven rectifier rolls were the most desirable way to provide the proper flow and minimize turbulence. Speed and direction of rotation of these rolls are important but once operating conditions are set they require little change. One roll may be near the entrance to the box, a pair of rolls in the center with the top of the top roll about at the liquid level, and another pair at the slice. For low machine speeds it may be desirable to use vacuum rather than pressure in the box.

By means of this flow box more water can be used, and this may give better burst, porosity, easier drying, and improved supercalendering results.

(*2*) *Press Sections.* One item of interest is a vacuum pickup section to carry lightweight sheets from the wire to the first wet press. The sheet after passing the suction couch roll is picked up by a felt which is backed up by an adjustable vacuum contact roll. This permits higher speeds where wet web breakage is now a limiting factor. While showers are used on an ordinary pickup felt, with the vacuum felt arrangement the felt is dry and moisture is not needed for adhesion. This permits easier drying and higher production.

A variation of the dual suction press was also described.

Another press variation described was the open run suction press in which the sheet touches the felt at the nip point only. Threading the sheet through the section is more difficult with this arrangement.

(*3*) *Drives.* The Beloit differential gear box type of drive was explained with blackboard sketches. Its similarity to the differential unit on an automobile rear axle was described. The power from the main line shaft is applied to the shafts equivalent to those of the two axles, with a variable speed changer such as the Link-Belt P.I.V. unit inserted between one shaft and the main line. The torque emerges at the third member or propeller shaft for drive purposes. The small adjustable differential factor permits minutely accurate and positive draw adjustments for each section. Total sheet shrinkage with an old-type drive which in one case was about 8%, was reduced to $5^1/_2$% with the new drive due to precise draw control.

Guests were invited to write to the Beloit Iron Works for more details on this equipment. Mr. Skinner joined Mr. Swartz in contributing to a good discussion that followed the talk.

ROBERT J. SEIDL, *Secretary*

Empire State (Western District)

On Wednesday, Feb. 6, 1952, the Western New York Group of Empire State TAPPI met at the Prospect House in Niagara Falls, N. Y. Instead of the regular technical meeting, a ladies' program was presented. Approximately 70 members and guests and wives enjoyed an evening of entertainment.

After dinner, community singing started the evening's festivities. J. S. Reichert, Chairman of Empire State TAPPI, spoke briefly on Boy Scout Week. A short skit on Cub Scouting was presented by one of the local Cub Scout groups. A short film and cartoons were shown. After a brief intermission, dancing and cocktails in the main ballroom were enjoyed by the entire group. Due to the success of this venture, the ladies' night program will be held annually.

S. M. SCALLETTA, *Publicity Chairman*

Empire State (Central District)

The Central District of Empire State TAPPI met at the University Club in Syracuse, at 7:00 p.m. on January 11. Eighty-two attended. Professor C. E. Libby presided as chairman.

The group was honored to have many distinguished guests.

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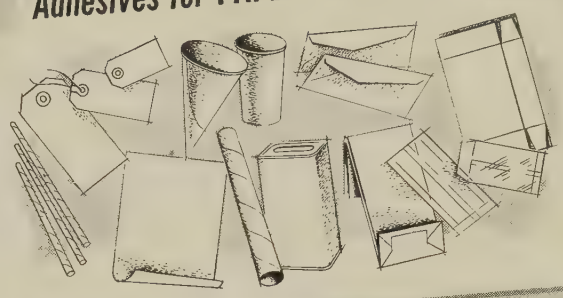

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The chairman introduced: Ralph Peters, Assistant Superintendent, Eastman Kodak Co.; B. Payne, Assistant Superintendent, Eastman Kodak Co.; Walter Metcalf, Technical Director, Stevens & Thompson Paper Co.; Phillip Goldsmith, Development Engineer, Pusey & Jones Co.; Harold Simons, Manager, Sweet Bros. Paper Co.; Dick Sweet, Sweet Bros. Paper Co.; and Bert Sweet, Sweet Bros. Paper Co.

Professor Libby sent condolences and expressed sympathy to the family of Robert Engelhardt who succumbed due to a hunting accident. Mr. Engelhardt was at one time Superintendent of the Oswego Falls Corp. in Fulton and at the time of his death was with the United Board and Carton Co. of Urbana, Ohio.

Harold Simons introduced Dick Sweet who in turn introduced the guest speaker of the evening, Hilliard D. Cook.

Mr. Cook gave a most interesting talk, illustrated by slides on "Problems of Cylinder Paper Machine Design and Operation." Mr. Cook's remarks follow:

Cylinder Machines—Some Problems of Design and Operation

H. D. Cook

This discussion is backed by personal practical experience in the tissue field which may not be sufficiently comprehensive to apply to cylinder machines in general because the tissue tonnage formed in this manner is small compared to board tonnage. On the other hand, the opinion is ventured that tissue demands more flexibility in the forming part and is more exacting than board, so it may be that minor problems for the board man may be major ones for tissue mills and the understanding that makes things possible to make tissue may also be valuable to the board man.

The introduction will seem very elementary to a large number of persons because it is assumed that many are unfamiliar with cylinder mold operation. It would seem wise to review the simple, fundamental principles of operation first as they naturally lead to the various changes that have been made to meet or compromise with the difficulties encountered.

The first man who constructed and operated a cylinder machine probably reasoned that if he could cause a wire-covered cylinder to revolve in a vat of stock and remove the water which drained through the wire cover, or face, the fibers which did not pass through the wire, being retained on its surface, might be couched off as a sheet of paper.

This did not work very well because the fibers which were stopped by the wire did not stay in place. The currents created by dragging the mold through the water washed the fibers off the wire face as soon as they were deposited and redeposited. The stock at the side of the vat where the surface of the mold left the water became concentrated by loss of water to the inside of the mold. The fibers clotted in groups in this concentrated condition. The clots of fibers last deposited on the wire as it left the vat were the only fibers that stayed on to reach the couch. This did not produce a sheet of paper that seemed useful, so what to do.

In order to stop the fibers from being washed off the face of the mold it seemed necessary to stop the relative motion of the mold through the stock. It was not possible to stop the mold and get the paper to the couch so it was arranged to move the water with the mold.

The vat shown in Fig. 2 evolved as a result of this reasoning. It can be seen that the mold is now revolving inside of a scroll or "circle," and that the stock suspension is forced to travel with the surface of the mold by the difference in level between the point where it first meets the mold and the point where the mold leaves the water. The space between the mold and the scroll or circle, the walls of the channel through which the stock must flow, becomes less and

H. D. Cook, Superintendent, Sweet Bros. Paper Co., Inc., Phoenix, N. Y.

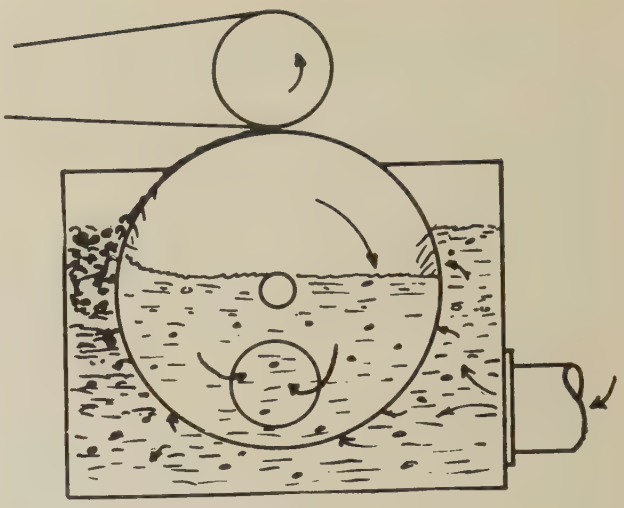

Fig. 1

less as the cylinder approaches the point of leaving the vat. This is, of course, done in an effort to maintain the same velocity of water during the time that the mold is in the vat. As water drains through the wire face, the volume traveling around outside the face is reduced, and in order to maintain the same velocity with the reduced volume, it must flow through a smaller channel. When stock is first deposited on a wire cloth the initial drainage rate is very high compared to the average rate throughout the time of deposition. The rate is logarithmic plotted against time. That is known from experience with freeness testers. That is why the distance from the scroll to the wire decreases rapidly at the start and slowly near the end of the passage.

Now, obviously, the shape of this passage can be made correct for one drainage rate only and no practical way has been found to alter it to meet changes in drainage rate. There are tremendous differences in rate to be encountered, caused by stock condition, basis weight of paper, and temperature of water. If this shape is accurate for one day in five years, it is an accident. It must then be a compromise.

There is another gross imperfection here, also. One of the sides of this channel moves with the flow and the other does not. The friction between the moving water and the stationary side of the channel, the scroll, sets up eddy currents that disturb the uniform settling of the fibers on to the face and even cause washing away of deposited fibers No practical way has been found to cause the surface of the scroll to move with the surface of the mold.

Now, since this is a diagram of a practical board vat, the board men will think this discussion is theoretical because it has nearly been proved that it cannot work and they know that it does—for them. They are able to operate by virtue of their very slow speeds and by piling sheet upon sheet so that the laminations hide the imperfections. The faster

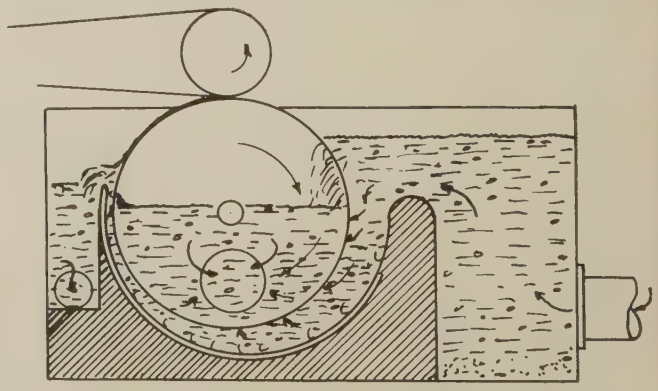

Fig. 2

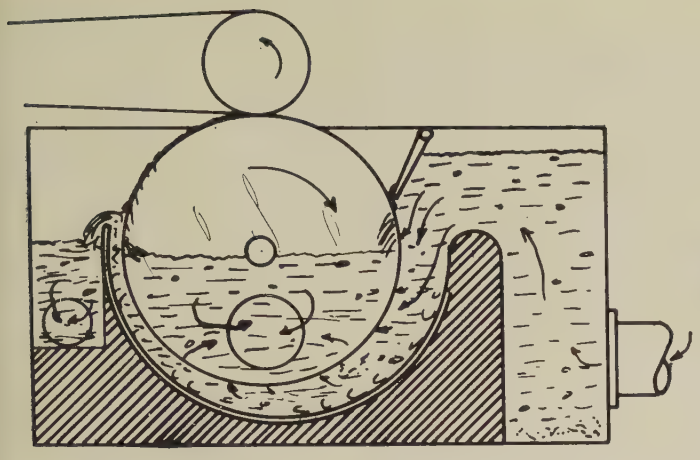

Fig. 3

water flows the more violent are the eddy currents set up, and while the cylinder board machine may be traveling less than 100 f.p.m., surface speed, tissue manufacturers are making paper on cylinder molds at 400 to 600 f.p.m.

There is a third serious imperfection in this design which should be pointed out because it leads to the next evolution. While the water may be flowing between the scroll and the face at approximately the speed of the face, there is a dead point where the bare face first meets the stock. The motion of the stock here is directly toward the face, and since fibers tend to line themselves up in the direction of flow, a large proportion of them hit the face end on. As soon as the end of a fiber hits the moving face and is attached, the motion of the face through the water drags the fiber with it while it is still laying down on the face. The free part of the fiber is thus feathered in the direction of travel and becomes fastened in the machine direction. Drainage is very rapid here. Probably one half to two thirds of the weight of the sheet is formed before the stock enters the scroll channel or circle and is accelerated to the speed of the face or thereabouts. Many fibers laying in the machine direction make a bad case of "cylinder formation." One-way strength is recognized as characteristic of cylinder formation for the reasons given. It forms somewhat in the same manner but to smaller degree during the passage around the circle. Figure 3 will show something that has been done about it.

An apron board has been added which prevents stock from flowing to the bare face of the mold until it has been accelerated to the speed of the mold in the direction of face travel. This is a great improvement in forming ability and, in fact, this design is a practical tissue vat for making toilet, waxing, sheet tissue, etc. There is another refinement, however, which is helpful although the author cannot rationalize it by theory. This is the slice board or fourdrinier board shown in Fig. 4.

This slice board is adjustable toward and away from the mold. We find that the nearer we can place the slice to the face and still pass enough water to maintain an active overflow at the back, the higher will be the cross strength. Also,

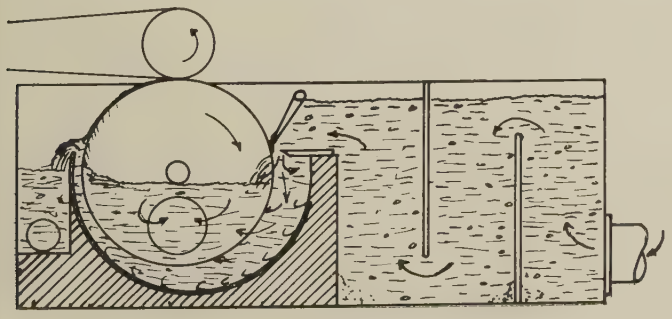

Fig. 4

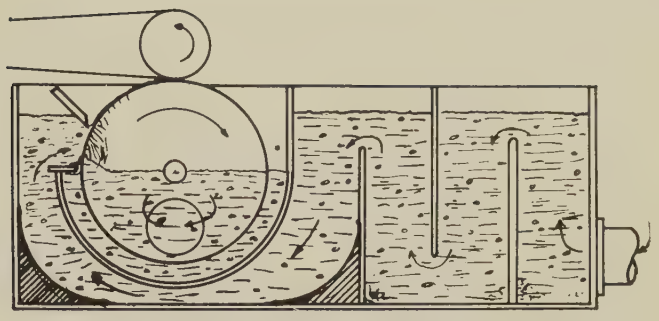

Fig. 5

the lower we can run the apron the better, the limit being that both wire face and rubber apron wear rapidly when it is carried too low.

The man responsible for both apron and slice board is W. E. McIntyre and it is only fair to pay tribute at this point. Maybe the reason why it works is that while the shape of the circle (scroll) cannot be changed to meet changed conditions of stock temperature and basis weight, the position of the slice board can be; another approximation or compromise.

It will be noted that the vat has been extended to make a long flow box with baffles to quiet and even out the flow of stock before it reaches the face. Some papermakers set great store by this and others consider it of little value. This, by the way, is a diagram of the vat at Sweet Bros. Paper Co. which is called a "McIntyre Vat" and was built by Shartle Bros. Machine Co. Mr. McIntyre realized the deficiencies of the conventional vat as have been pointed out so far and attemped to compensate for them by making adjustments possible in the circle, slice, wingboards, and apron board. The author is sorry to say that these were removed before he had a chance to investigate them so he cannot report from experience on how practical they were. Some have not been generally adopted by the trade.

At this point partial apologies should be made to Sandy Hill Iron and Brass Works, Downingtown, and possibly others who have made movable molds. Realizing that it is impractical to change the circle they have made the position of the mold adjustable within the circle. The author has had no practical experience with this, but it does not appeal to him very much, one reason being that the circle should not be a circle anyway. Using an eccentric circle of larger diameter gives an arithmetic constriction of the channel through which the stock flows around the mold, whereas a logarithmic constriction is needed. Another point is that opening the channel at the back of the mold beyond a certain point will get you into trouble. You should change the diameter of the circle not the position of the mold, if you are going to use a circle.

Another disturbing factor here is centrifugal force. Water moved by the mold at its surface speed near its rim has a pressure outward caused by centrufugal force. Over the internally submerged sector of the cylinder this can be

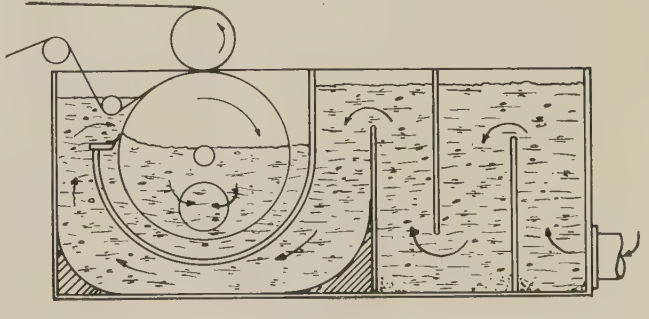

Fig. 6

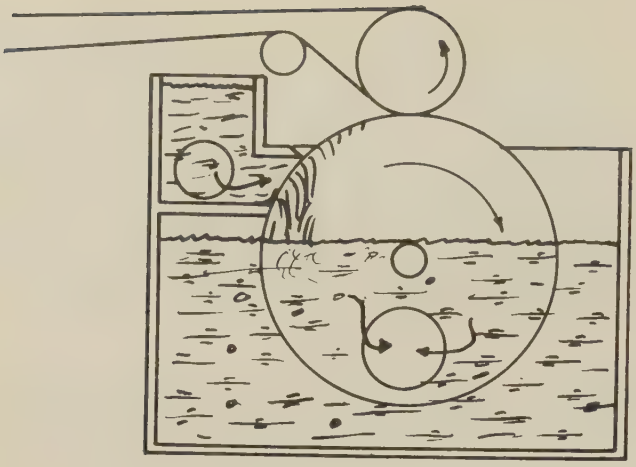

Fig. 7

compensated for by the difference in hydraulic head, but what about the sector above internal water as the face leaves the vat? Water is carried up by rods and spiders, and the gravity component is not toward the center of the moving mold so its resolution in a centripetal direction, compensating for centrifugal force, is not great. Some machines are operating at speeds where centrifugal force exceeds gravity anyway, so the only answer is air pressure. Enough air pressure or suction must be used inside the molds to balance centrifugal force.

Let us leave centrifugal force now and a few other unsolved problems of this type of vat and mold. We can return to them after we have examined some other specialized tissue vats.

Facial tissue and wadding are very light sheets on a mold or wire, much lighter and freer than 10-pound tissue or 10-pound wet creped toilet. These sheets drain so rapidly that it is impractical to remove water from the inside of the cylinder fast enough to keep them on the face of the mold. It appears that only a short length of wire, perhaps 4 to 6 inches, is sufficient to form a satisfactory sheet. Figure 5 is a diagram of the vat arrangement most commonly used to form facial and wadding, using only a few inches of the wire face.

It can be seen that here the stock flows around the outside of the circle, over an apron board, and against the wire at a point only a few inches from the top water level. The slice board extending from the top of the vat to a short distance from the mold face below the water line prevents the concentrated stock from rolling against the mold. Some papermakers use a dip roll at this point to accomplish the same purpose, as shown in the next figure.

Figure 6 looks rather complicated, but it works. The author knows of one mill that has a slice board on one machine and a dip roll on another. He has not worked with a dip roll himself and would not want to do so, unless someone can give several good reasons for its installation.

This vat design is not flexible, any more than other designs, probably less so. Assume you have the apron board at the best level for a free sheet and you want to change to a heavier, slower sheet. Then, you need more wire surface on which to form it. The only way that you can get it is to lower the apron board; this involves building over the vat. If you lower the apron too far to obtain more wire, you lose forming ability by dragging the face through stationary stock. The author's limited experience with this vat indicates that a 10-pound sheet on the face is about as heavy as practical. He would not want to make that statement positive.

There is another scheme that is used in at least one mill in England, but it has not been reported in this country. It is a natural evolution of this facial vat as Fig. 7 will show.

It will be observed that this gives some means of applying a head or pressure to the stock as it is exposed to the mold. It was said to be operating on Japanese tissue but no details of design or performance are available. It is interesting because it suggests an adjustable head to compensate for different speeds. It also suggests that if stock could be caused to pass through the box from end to end without concentrating to increase basis weight beyond tolerance it might be possible to cross grain the sheet. It is also interesting because it leads to another design for making fourdrinier formation on a cylinder which, unfortunately, the author is not at liberty to discuss.

There is another vat design which, though it has no place in tissue, is used by board manufacturers and is included here to forestall a protest. It is an anomaly as far as tissue men are concerned. Figure 8 shows a countercurrent vat.

It will be observed that here the stock travels in the opposite direction from the mold travel. What is gained by this the author will leave to some board man to explain.

Now, before we leave vats, let is examine a new mold that has been offered by Pusey & Jones during the last few years. This appears to have more promise than any innovation since the circle was created. In order to consider this, let us first return to Fig. 5 which shows a good tissue vat. Remember that it was stated that we must apply suction to help hold the sheet on the wire face at higher speeds.

Note that half the wire above the line is bare. Air can rush in through this bare face without doing any good at all. This air, so freely admitted, overloads the exhausting fan and makes it necessary to use a fan and motor which seems very large in proportion to the useful work that it has to do. It seems impractical to use a fan and air ducts large enough to produce a draft of over 11 or 12 inches of water. Some mills are partially enclosing this bare wire with a housing but this is difficult to do efficiently. The shower must operate inside the housing. The housing must be opened to clean the mold with steam which must be done often when using pitchy stock or waste papers. It is not practical to seal the housing to the mold without the use of another apron which would double the wear on the face. Pusey & Jones' answer to this is shown in Fig. 9.

This mold is built without spiders which is not an innovation because all are familiar with hollow dandy rolls. The spiderless or hollow construction of this mold does, however, permit the introduction of a suction box inside the mold. It will be seen by the diagram that the suction box used occupies the quadrant of the mold which supports the paper from the water line to the couch where most of the disturbance is encountered, especially at higher speeds.

Vacuums can be maintained in this box comparable to

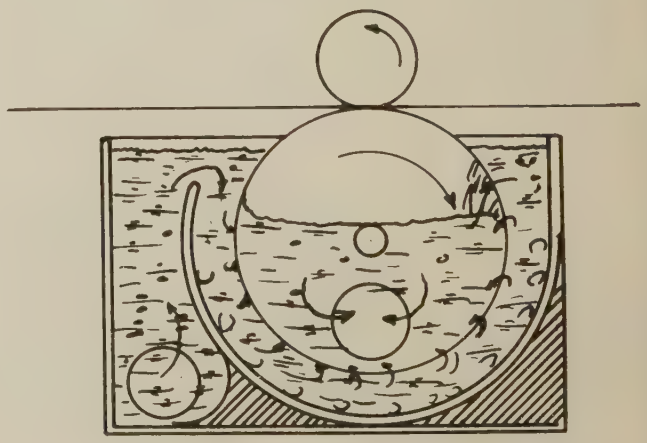

Fig. 8

those used in suction press rolls, if you want to provide pumps and power equal to it.

The surface of the inside of the mold is so constructed that a good seal can be maintained between the box and the inside of the mold.

This mold was developed to produce heavier sheets of board on a single mold at higher speeds, and is said to be successful. Its possibilities for forming tissue at higher speeds are very interesting, but it is not possible to report trials.

Higher speeds, naturally, demand higher vacuums to counterbalance centrifugal force which, as pointed out, will throw water from the inside through the face carrying the sheet with it at some calculable critical speed which, for our 48-inch mold is 475 f.p.m. Higher vacuums tend to hold the sheet to the face where you want it released at the couch, as well as at other points where you want it retained. We find that it is hard enough to couch the sheet off the face with 10-inch water vacuum. In the case of the Pusey & Jones mold, we wonder if we will be able to couch the sheet after we apply enough vacuum to hold it on the face until it reaches the couch. It seems obvious that the couch can be moved beyond the edge of the suction box, so that it is no longer held by suction, but if the fibers have been pulled into the meshes of the face, it still may be hard to lift.

In this case, a suction couch manufactured by Downingtown, which is useful with the present mold, might be doubly useful.

This covers briefly the different arrangements of vats that are known to the author—all for the special purposes and all, more or less efforts to make a cylinder do jobs that a fourdrinier can be adapted to by changes under the control of the machine tender.

It has been pointed out that it is desirable to have the stock travel around the circle, or scroll, as the author would prefer to call it, at the same speed as the wire surface to avoid dragging the forming sheet through the stock. In order to do this the stock must be accelerated to that speed by a difference in head between the inlet and outlet of the circle equal to the head behind the slice on a fourdrinier.

In either case, the head is easily calculable by the formula $V = \sqrt{2gh}$. This indicates that for 450 f.p.m. a difference in level of 10 inches will be required. This is not unreasonable, but consider this:

If this velocity is maintained completely around the circle, stock will be ejected at the backfall with a velocity which will throw it up to its initial level. $V = \sqrt{2gh}$ solved for h gives the same h from either direction.

Almost all tissue machines are operating at 450 f.p.m.; some are operating at 600 f.p.m. which would require a difference in level of 19 inches. Now who has a vat that is squirting water into the air 10 or 19 inches up from the circle overflow?

It is obvious that we are not maintaining velocity completely around the circle. Most machines are dragging the face through the stock as the overflow is approached with a relative speed difference of 200 to 300 f.p.m. So, also, a "cylinder formation" with its directional strength and evidence of wash is being produced.

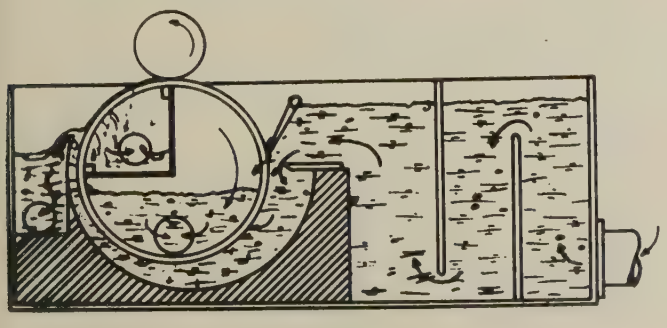

Fig. 9

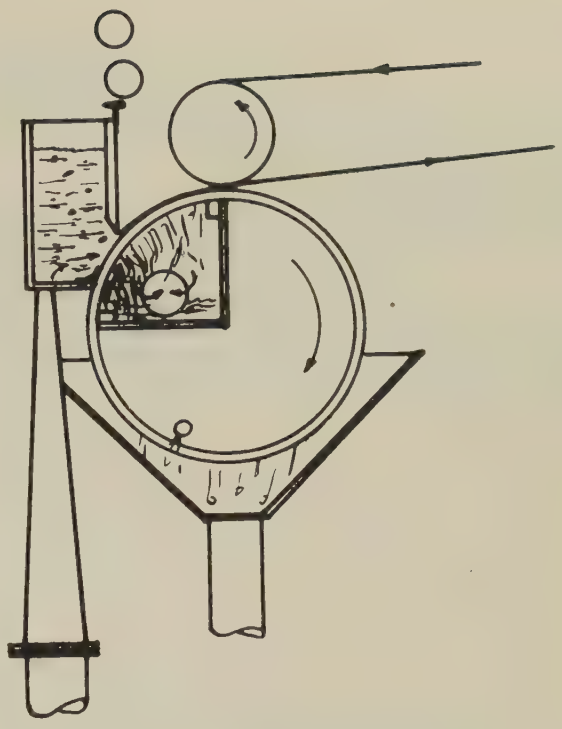

Fig. 10

The stock could be ejected at the circle overflow with the proper velocity if a doctor-deflector could be arranged to keep the ejected stock away from the formed sheet, one that would fit exactly enough to operate close to the mold face, and rigid enough to maintain exact and equal distance between its slice edge and the face, but it has not been reported.

To sum up: the author has tried to show why a cylinder machine is a poor means of forming paper at best.

It is inflexible in that to change from one grade to another or from different weights, or speeds, for one grade, changes need to be made which are impractical to make.

It is poor at its best because means have not been evolved to prevent serious disturbances during the formation of the sheet.

It cannot be operated at higher speeds without defying the fundamental law of gravity.

Changes which are made at considerable cost, in an effort to make it perform like a fourdrinier still leave us with basic handicaps of a cylinder machine.

If it is believed that this discussion was presented from a purely theoretical or speculative point of view, consult, any board mill operator. They may not be able to theorize but they sure have the practical experience to confirm these statements and they will.

Now here is something that the author has dreamed up in connection with the vacuum mold shown in Fig. 9. From a tissue point of view what is the use of the mold sloshing all the way around the circle when the sheet could probably all be formed on the quadrant over the suction box? Surely facial and wadding could be made on that sector at rather high speeds with the help of the vacuum: 10-pound toilet, 12½-pound embossing crepe, and many other light tissues could be produced at practical speeds at least. Then why not lay out a forming part like Fig. 10?

Here the stock rises into a headbox through a flow distributor: the head in the headbox can be held at any height to correspond with the speed as on a fourdrinier machine. The wire exposed to the box can be whatever experimentation before design indicates to be best. The slice lip can be and should be flexible and adjustable with the same precision as a high slice on a fourdrinier machine. The slice opening should be adjustable as a whole as on a fourdrinier. There is no need of any vat or circle so why have one? A drip pan

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under the mold should be enough. The mold being hollow the mold shower could be installed inside the mold at the point that we like best, like in a hollow dandy roll.

Now, this would appear to give with some flexibility. Whereas in a facial mold we cannot change the area of exposed wire to compensate for different drainage rates nor can we practically change the shape of the circle in a conventional vat for the same purpose, here we can change the vacuum inside the mold throughout a wide range. We can also change our slice opening and consistency for the same purpose.

In this vat we do not have to worry about eddy currents set up by the stationary circle. We do not have to worry about slip holes caused by the centrifugal force of the turning mold. This force can be balanced by the vacuum. Here we can have a head behind the slice to correspond with high speeds without throwing water up to the same level on the other side of the circle. It would appear to answer about all the problems, and even though some imperfection can be seen, it is believed that it is a good idea and worth trying.

Judges of the Empire State (Central District) Junior Prize, l. to r.; Harry Gray, Oswego Falls Corp.; H. D. Cook, Sweet Bros. Paper Co.; and R. K. Prince, American Cyanamid Co.

Contestants for the Junior Prize; David Born, left, and Robert Hitchings, right

Meeting of Feb. 1, 1952

The Central District held its regular monthly dinner meeting on February 1 at the University Club in Syracuse at 7:00 p.m. Fifty-two attended. A social hour preceded the meeting. Professor C. E. Libby presided as chairman.

The high light of the evening was the prize speaking of the two aspirants from the Central New York Group who competed in the Annual Empire State TAPPI Prize Speaking Contest. The participants were Robert Hitchings of the College of Forestry who spoke on the subject: "The Effects of Shake on Low Speed Fourdrinier Operation" and David Born of the College of Forestry whose subject was: "The Effect of Silicate and Lime on the Bleaching of Chemigroundwood Pulp with Hypochlorite."

The three judges for the content were: Harry Gray, Oswego Falls Corp.; Ralph Prince, Empire TAPPI; and Hilliard Cook, Sweet Bros. Paper Co. For purposes of instructive criticism, balloting was done by the audience.

Mr. Hitchings was proclaimed the winner by both the panel of judges and the results of the ballots. These papers will be published at a later date.

DANIEL V. LENT, *Secretary*

Empire State (Eastern District)

The Eastern District of the Empire State Section met at Milfranks Restaurant in South Glens Falls, N. Y., on Jan. 17, 1952.

H. L. Field of the West Virginia Pulp and Paper Co. Mechanicville, N. Y., addressed the group of 75 present on "Semichemical Pulping of Hardwoods." This paper will be published at a later date.

R. D. LEWIS, *Publicity Chairman*

Empire State (Northern District)

On January 10, 80 members of the Empire State Section, Northern District, met to view a film on the history of papermaking shown by representatives of F. C. Huyck & Sons, Rensselaer, N. Y.

The February 14 meeting was scheduled as Peddlers' Night and was an enjoyable affair. Following dinner several vaudeville acts were presented.

On April 10, R. A. Recknagle, Chief of the Forestry Dept. of St. Regis Paper Co., Deferiet, N. Y., is scheduled to discuss some current woodlands problems.

T. EVERETT ENGLISH, *Secretary*

Wood Handling Methods in Pulp Mills of Eastern North Carolina and Virginia

C. L. WILLS and C. L. HILDEBRAND

THE purpose of this paper is to describe methods of handling and storing pulpwood now in use in pulp mills of Eastern North Carolina and Eastern Virginia. The authors' particular first-hand knowledge of the subject came from redesigning and modernizing their own woodyard, the description of which will be given special emphasis in this paper. Also described will be the interesting and unique features noted in other mills.

The system of storing pulpwood in 5-foot lengths jackstraw style in long piles parallel to a conveyor and handling by crane is fairly common and was decided on for our mill in 1946. Previous to this, wood was ranked about 8 feet high all over the yard and moved into and out of storage by trucks and manual labor. This storage area was from 3 to 7 feet lower than the ground around the mill buildings and drainage was not too good. The top surface was composed of bark from 1 to 3 feet deep. In periods of continued wet weather, this ground became a bog that was almost impassable to vehicles. The most remote piles were 700 feet from the barking drum. At times during rainy weather the production of the plant was curtailed because daily receipts of wood were down and wood stored in the yard could not be brought to the barking drum at a sufficient rate. A short conveyor with curved incline fed wood into the barking drum. Wood was loaded into the conveyor manually from trucks delivering either from the yard or from the woods and from rail cars, mostly box cars, on a siding that ran parallel to the conveyor. The capacity of this system was inadequate and the operating cost excessive.

The new woodyard was designed by the plant engineering department. Before beginning design work a visit was made to several other mills and the good features and bad features in these mills noted. The final design incorporated some of the good features seen with some original improvements of our own. The area available made possible a storage capacity in jackstraw piles 50 feet high of 16,000 cords. The new conveying system was designed to handle 50 cords per hour. Two diesel-powered crawler cranes of 2-yard capacity were purchased with 80-foot booms, one equipped with a pulpwood orange peel grapple and the other with a hook. The original log conveyor feeding directly into the front of the barking drum was left intact. Two hundred feet to the east and parallel to the old conveyor was erected a new loading conveyor 520 feet long broken into two flights of approximately equal lengths. At right angles to the new loading conveyor was built a transfer conveyor, 200 feet long, not designed for loading, to carry the logs from the discharge of the loading conveyor to the barking drum. The discharge of the transfer conveyor was set sufficiently high above the barking drum to leave room for the necessary chutes to go with a second barking drum. Arrangements were made for two storage piles on each side of the new loading conveyor, each having a capacity of 3500 cords. Also space was provided on the west side of the old conveyor for a pile of 2000 cords which made a convenient place for storing hardwood. For fire protection, the storage piles on the same side of the conveyor were separated from each other by 40 feet and those on opposite sides of the conveyor were separated by 100 feet. The general arrangement of the yard is shown in Fig. 1. In preparing the storage area, it was necessary to remove an accumulation of old bark to an average depth of 3 feet and backfill with sandy loam from the company's adjacent land to the east. This was done by a local road building contractor using carryalls and bulldozers. The operation was set up so that bark was hauled away on one leg of the haul and fill material brought in on the return trip. Grading was worked out so that drainage was from the edges of the piles toward the center and the water conducted from the center by pipes or ditches.

A railroad siding was installed with its center line 11 feet east of the center line of the new conveyor. A roadway was provided to the west of the new conveyor with its far side 43 feet from the center line of the conveyor. This was the space calculated to be required for the movement of the cranes.

CONVEYOR DESIGN

The new conveyors are of welded structural steel construction. The loading conveyor rests on a concrete slab 10 feet wide by 10 inches thick which is supported on two creosoted pine piles every 10 feet of length. The transfer conveyor is supported on steel bents approximately 30 feet apart, each bent resting on a concrete slab supported by two piles.

The loading conveyor is built in two flights on the same center line since both flights had to be close to the railroad track. The sides of the conveyor are straight, without the usual aprons, and are made of $^1/_2$-inch plate braced by 3 $^1/_2$ by 3 $^1/_2$ by $^1/_4$-inch angles on the under side. The sides are set at an angle of 35° from the horizontal. The width of the conveyor is 9 feet at the top plus a 6-inch wide walkway along the top on the track side to make it easy to walk from car to car. At the bottom is a trough 20 inches wide by 5 inches deep in which the chain runs with a similar trough 12 inches below for the return chain. In the bottoms of these troughs are $^1/_2$-inch thick wearing plates tack welded in place. A cross section of this conveyor is shown in Fig. 2. The chain is C-132 with box-shaped welded steel flights every 6 feet. In order to drag out and distribute the piles of wood dropped in by the grapple 3 by 5-inch angles inverted were welded to the sloping sides at right angles to the center line of the conveyor spaced 20 feet apart on each side and staggered so that an angle on one side is opposite a space on the opposite side. They are very effective.

Fig. 1. Aerial view of woodyard and mill

The most remote loading conveyor has a flat portion 190 feet long and an inclined portion 70 feet long. The middle conveyor has 155 feet flat and 105 feet sloping. All of the flat portion was prefabricated in 10-foot lengths by a nearby steel fabricator and delivered to the job by truck. There it was set on the foundation slab and welded together. The inclined portions were fabricated on the job by a local steel

C. L. WILLS and C. L. HILDEBRAND, Halifax Paper Co., Inc., Roanoke Rapids, N. C.

erecting contractor using stock lengths of material purchased by the company.

In order to provide for expansion the concrete slab is separated by a $^3/_4$-inch wide slot every 50 feet. All of the base plates of the conveyor were bolted down through slotted holes in the base plates. During hot weather before the conveyor

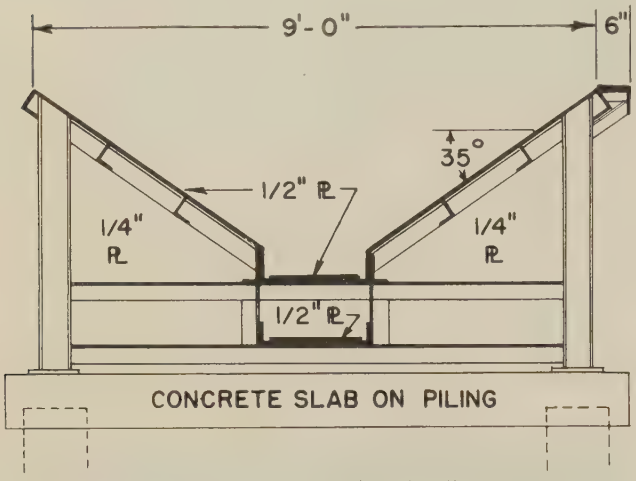

Fig. 2. Cross section of Halifax loading conveyor

was started up, portions of the conveyor would suddenly give a groan and move on the slab in the base plate slots. After the start-up no more sudden movements were noted, and it was assumed that vibration of the entire conveyor allowed the expansion movement to be gradual.

The transfer conveyor is constructed of $^1/_4$-inch plate suitably braced with the side frame built as a beam to support

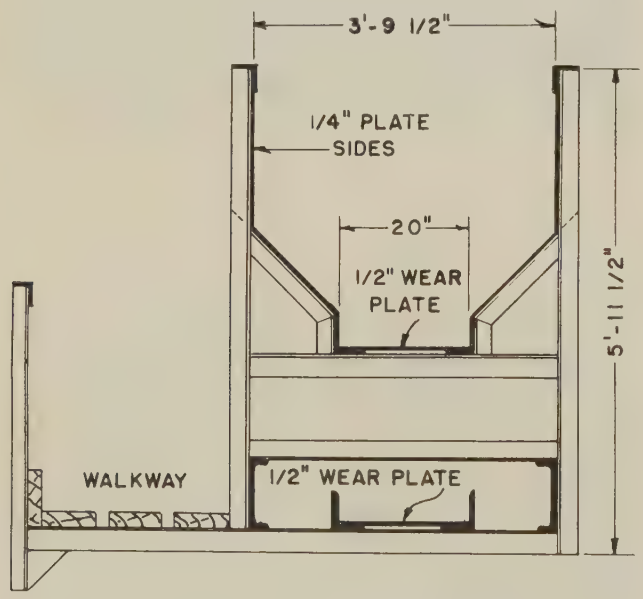

Fig. 3. Cross section of Halifax transfer conveyor

the structure between bents. The cross-section area is sufficient to handle the design capacity of the conveyor with no extra width for loading. Troughs similar to those in the loading conveyor carry the hauling chain and the return chain. These troughs also have $^1/_2$-inch thick wearing plates tack welded in place. The chain is the same as in the loading conveyors. For a cross section of the conveyor, see Fig. 3.

Transfer points from conveyor to conveyor presented the greatest problem. In the straight transfer between flights of the loading conveyor, the wood is elevated so as to give a distance of 5 feet 2 inches between the bottom of the sprocket of the discharging chain and the top of the receiving chain. This is to prevent the 5-foot logs from getting caught between two chains. Since both conveyors are on the same center line to keep them close to the track, the wood falls directly on the receiving chain. Since this seemed to be a bad feature, a deflecting plate, sloped 45° from the horizontal, was put over the receiving chain. In operation it was found that logs would lie with one end on this plate and the chain could not pull them off, thus causing frequent jams. When the plate was completely removed this trouble was corrected and the transfer operated day after day without an attendant. Some trouble has been experienced with breaking pins in this

Fig. 4. A straight conveyor transfer

section of the chain, but we have not been able to determine for a certainty whether it is caused by this pounding or by other factors. Figure 4 shows the straight transfer.

At the right-angle transfer point, in the first installation a toboggan-like curved chute was built to take the wood from the discharge of the loading conveyor and deliver it into the transfer conveyor with the log entering the transfer conveyor already moving in the direction of travel of the transfer conveyor. This device would operate about 5 minutes until a jam would occur because logs would not come all the way off the chute. The entire chute was removed and the sides of the transfer conveyor opened out at the receiving point. This transfer point now works day after day without attention and has no attendant. The distance between the bottom of the discharge sprocket and the top of the receiving chain is 8 feet. The logs do not fall directly on the receiving chain but hit the side of the trough first. No trouble with chain

maintenance or trough maintenance at all has occurred because of this. Figure 5 shows this transfer.

In both transfer points there is a tendency for bark to be carried around the discharge sprocket and back down the return chain. This has been partly corrected by leaving the return trough off as far from the head sprocket as possible and letting the bark fall into a chute which goes into the receiving conveyor. In addition to the chute a gap is left in the return conveyor trough a few feet back from the head sprocket and some of the bark falls out here. This helps in keeping the return trough clear, but a pile of bark builds up in the ground beneath the gap and has to be hauled away from time to time. Any bark which is carried all the way to the tail sprocket builds up in a pile around the tail sprocket until it begins to be carried back into the conveyor at which point an equilibrium condition is established. In designing the transfer points, and in making the changes during the initial operating period to eliminate jams, we came to the conclusion that eventually in a log conveyor, a stick of wood will work its way anywhere that you could place it with your hands, and that this principle should be kept constantly in mind in designing the conveyor.

Fig. 5. A right-angle conveyor transfer

WOODYARD OPERATION

In the operation of this system all rail cars are unloaded into the old short conveyor directly in line with the barking drum. Wood rack cars are unloaded by the crane with the orange peel grapple and box cars are unloaded by hand. Thus all rail wood goes directly into the mill. This is about 35% of the total receipts.

Trucks are loaded in the woods with a sling placed around each of two bundles of wood in each truck (see Fig. 6). The truck holds around $2^1/_2$ cords. When the truck reaches the mill the crane with the hook picks up each bundle by the sling and throws it on the storage pile. When the bundle hits the storage pile, it falls apart leaving the sling hanging from the crane hook. The sling is then returned to the truck. A truck can be unloaded in less than 2 minutes and as many as 280 trucks have been unloaded in 10 hours by one crane. Generally all truck wood goes into storage.

The storage piles are managed so that at any given time, only one pile is being filled, only one pile is being reclaimed from storage, and the others are being held static. Reclaiming is done by the crane with the orange peel grapple into the nearest loading conveyor. When a pile is being filled, no wood is taken out of it and the wood scaler's records show the amount in the pile at any time. On the day the pile being reclaimed becomes empty, and its contents become zero, an exact inventory based on the wood scaler's records can be taken. This is because all the other piles contain exactly what has been put into them, which is a known amount, with no wood having been taken out of them. By using this exact inventory on the day a pile becomes empty, a very close inventory can be calculated for any nearby day for accounting purposes, by using known receipts and estimated consumption for the intervening

Fig. 6. Unloading a truck with a crane

Fig. 7. Conveyor operator's house

few days. A pile becomes empty every 2 or 3 weeks. This method of rotating storage piles give a uniform turnover period for all wood, the oldest wood always coming out of storage first.

A control house set high enough to give a view of all the conveyors except the remote loading conveyor is located at the inlet to the barking drum. The operator stationed here starts and stops all the conveyors including the conveyor

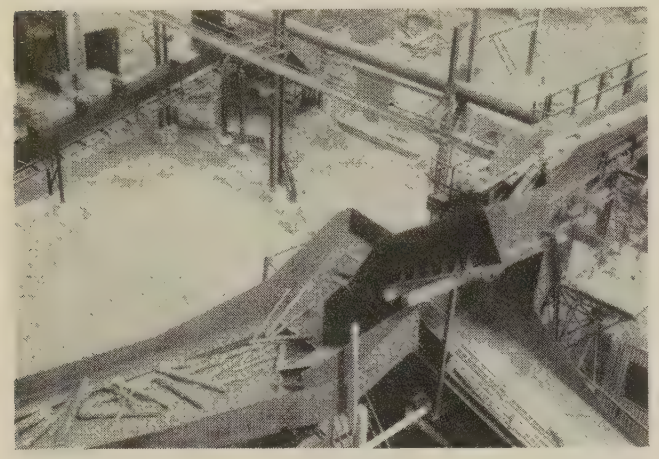

Fig. 8. A transfer into a rubber belt conveyor

taking wood from the barking drum. He can also stop the barking drum in case of trouble but cannot start it again. This is done by a drum switch control located in the electric control house which also houses the barking drum drive. In case of this kind of trouble the yard shift foreman will be on hand to take the necessary steps (see Fig. 7). The entire operation of unloading, storing, reclaiming, barking, and chipping requires 0.48 man-hour per cord of wood consumed

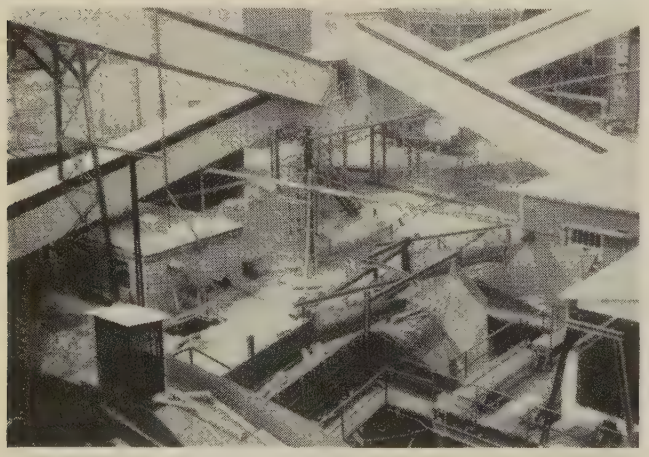

Fig. 9. A rubber belt feeding two barking drums

by the mill. In comparison before the yard was mechanized, the same operation required 1.95 man-hours per cord of consumption. The new system is handling 450 cords per day in a 24-hour operation while the old was doing 250 cords per day in a 16-hour operation.

EQUIPMENT MAINTENANCE

As to maintenance there have been occasional breakdowns of the cranes, but for all practical purposes they have been continuously available for the past five years. They are of ample capacity and the work they do is light for them. Some difficulty has been experienced with pins breaking in the loading conveyor chain nearest the barking drum. This section of the conveyor is subjected to the most severe service but no particular reason has been definitely established for causing this pin breakage. At the present time, there is an occasional pin failure but much less frequently than formerly. We do not know why unless the pin material has been improved. Pin breakage has always been less frequent on the transfer conveyor, and most frequently in the middle section which operates with the transfer conveyor.

Wearing plates $^1/_2$ inch thick in the chain troughs have been in service for about 4 years. At several points replacement was necessary after 3 years of operation but in the over-all picture it appears that $^1/_2$-inch wear plates should last about 5 years. This wear is entirely confined to the top, the loading trough, where the chain moves on the plate. In the return trough where the chain is held off the plate by the attachments there is very little wear. This could not be measured using a rule.

The 6-inch wide walkways along the top edge of the loading conveyors on the track side have become considerably bat-

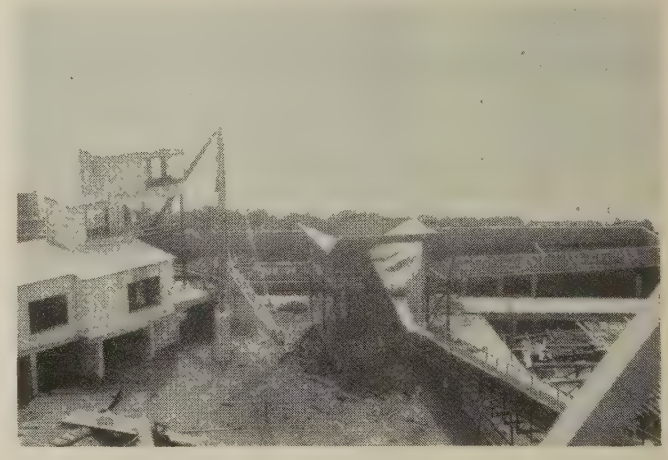

Fig. 10. Unloading a barge

tered, probably by wood falling on them when loading the conveyors. The loading conveyor structural supports have shown no damage except an occasional diagonal brace being bent. The $^1/_2$-inch thick sloping sides of the loading conveyor have shown no wear, but a minute sagging between supporting angles can be seen, although this should cause no trouble for many years.

FIRE PROTECTION

For fire protection an 8-inch loop of underground piping connected to the mill system was run around the storage area with 6-inch branch lines where necessary to individual hydrants. Nine hydrant houses were installed each having 200 feet of hose. At first it was planned to have monitor nozzles on towers at intervals around the piles, but then it was realized that this would seriously hamper the day-by-day operation of the cranes. It is planned now to mount a nozzle in the end of the boom of each crane, with suitable connections in the base of the boom for hoses from one or more hydrants, although we do not know yet how practical this will be. Also, as was stated earlier, piles are separated by fire lanes 40 feet wide one way and 100 feet wide the other and no pile contains more than 3500 cords.

RUBBER BELT CONVEYORS

In one mill in a recent addition of barking drums and conveyors, all new conveyors were designed with rubber belting instead of chains. Two are of 42-ounce, 7-ply duck with 1/4-inch rubber on top and 1/8-inch rubber on bottom and 72 inches wide. Two are of 32-ounce, 6-ply duck, 1/4-inch rubber on top and 1/8-inch on bottom and 36 inches wide.

Fig. 11. A gantry crane handling wood

The length of the longest one is 900 feet. Speeds are 240 to 300 f.p.m. The maximum inclination is 11° from the horizontal and no trouble has occurred from logs slipping on the belts. One of the belts 72 inches wide, which was receiving wood from two sources and delivering it toward the barking drums, during the initial operating period suffered large lacerations in the top rubber layer. After changes were made in the method of feeding it from one of the conveyors so

Fig. 12. Close-up view of gantry crane and conveyor feed hopper

as to eliminate logs sliding violently onto the belt from one side, the trouble ceased, and no further damage to the belt occurred. Figure 8 shows a view of the transfer point where the damage was caused. See Fig. 9 for the method of plowing off wood from a belt to feed two barking drums. In this installation the flow of wood to the drums is not constant. When a small amount of wood is on the belt nearly all of it goes by the first plow and on to the second barking drum. When a large amount comes along the first plow pushes most of it into the first drum and leaves a small amount to go on to the second. This results in a fairly even division of the wood between drums.

In the same mill, wood is received by water in barges and unloaded by means of stationary derricks with orange peel grapples into conveyor. At the loading point of each conveyor is a hopper with its bottom set above the conveyors. In the bottom of the hopper are two SS-150+ chains traveling 100 f.p.m. which drag the wood out of the end of the hopper and feed it onto the conveyor (see Fig. 10). Wood is also unloaded by trucks with a large gantry crane. The hook of the crane is engaged in the sling around each bundle of wood in the truck and the wood is deposited either on the storage pile or into a hopper similar to those at the river side which feeds it onto a rubber belt conveyor. This conveyor extends 480 feet between two long jackstraw storage piles and the crane and hopper travel on rails over the full length of the conveyor between the storage piles. When it is desired to reclaim wood from storage, an orange peel pulpwood grapple is attached to the crane instead of the hook, and wood is fed into the conveyor. While this is being done, incoming wood in trucks is unloaded manually into the end of an older chain conveyor which feeds into one of the other conveyors to the barking drum (see Figs. 11 and 12).

Fig. 13. Conveyor control tower

To start and stop all of the conveyors in the system, one operator is stationed in a tall tower overlooking the entire yard. He is in telephone communication with another man in a station near the barking drums. No other attendants are used for the conveyors. When occasional jams occur, the control tower man sends other man to clear them up. Figure 13 shows the control tower.

Figure 14 shows a transfer point in the older part of the system in which C-132 chains are used with attachments every 8 feet. Figure 15 shows a method of spreading out the bark coming away from the barking drums. Groups of chain are suspended above the conveyor. The purpose of spreading out the bark is to make possible better operation of a magnetic metal catcher further down the line.

BUTTON CONVEYORS

In another typical installation the woodyard at this mill handles an average of 1800 cords of wood during 24 hours of operation including wood receipts put into storage and wood recovered from storage for supplying the mill. At least 60 days' supply of wood can be stored on the yard with additional area available if needed but at the expense of double handling.

Four storage piles are located in two parallel lines, two piles in each line. The two lines are 60 feet apart and between the

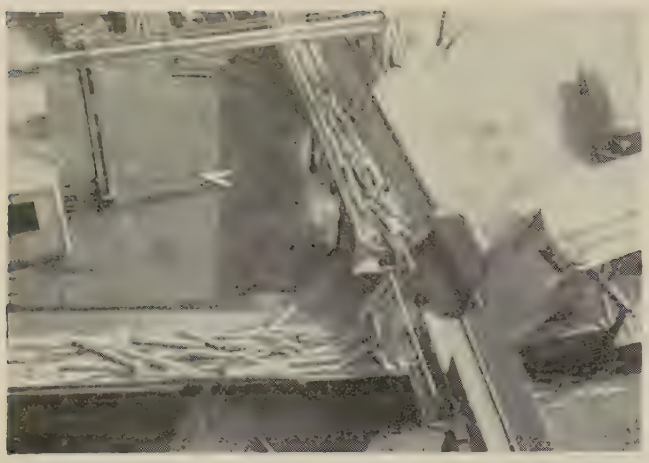

Fig. 14. Transfer point with chain conveyors

two lines is a stationary loading conveyor close to one line, one railroad siding serving the conveyor and a second track located close to the other line of piles. The piles in each line are separated 40 feet for fire protection and to allow access for recovery.

Wood received by truck is unloaded by a 2-yard crane with 60-foot boom and hook. The wood arrives at the mill with a chain sling in place and the crane needs only a hook. Wood is recovered from storage using two 2-yard cranes with 50-foot booms and orange peel grapples. A fourth 2-yard crane unloads wood from rail cars and serves where needed and provides some flexibility as a stand-by unit.

Fire protection is provided by spacing of the piles and by fire hydrants located approximately on the corners of each pile.

The log conveyor is of the loading type having sloping sides constructed of railroad car rails. A 1-inch diameter steel cable with buttons spaced at 3-foot intervals is used for moving the wood in the trough. The conveyor rises on a gradual incline to feed the two barking drums The cable and buttons are relatively light and are easily pulled up off the bottom of the trough at the start of the incline. Bark often builds up at this point and causes some trouble. Other than this, the button-type conveyor drags give good service in this installation.

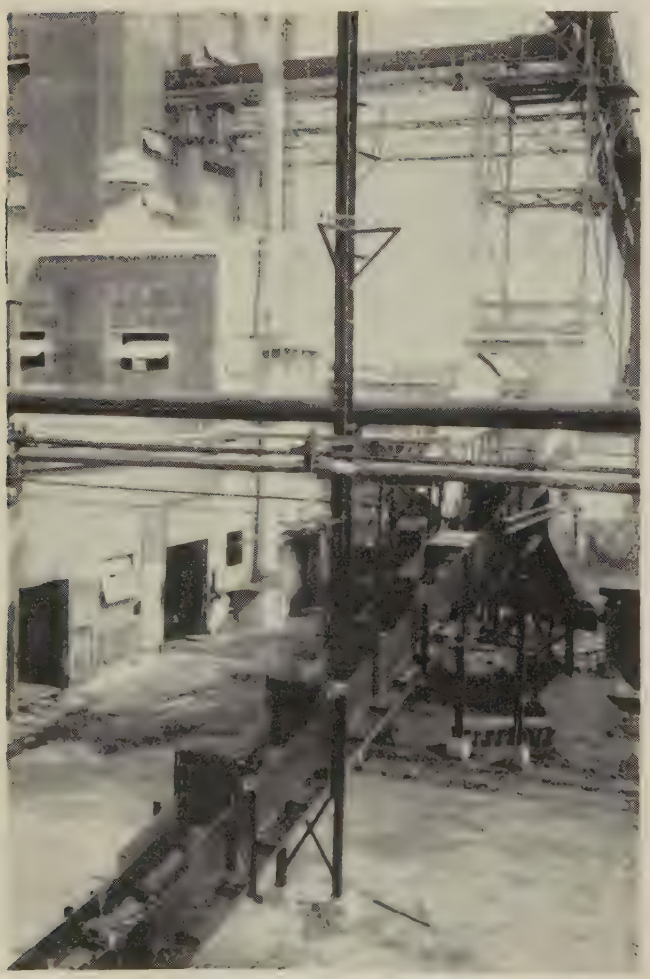

Fig. 15. A method of distributing bark on a conveyor

Fig. 16. A sorting table and control tower

Two drum-type barkers are fed by the button conveyor. These drums are side by side and at right angles to the conveyor. Distribution to the two drums is accomplished by having one side of the conveyor left off at the first drum. All wood on the other side of the chain is carried to the second drum. All wood on this side of the chain then goes to the first drum. Distribution is fairly equal, but no adjustment of distribution is possible.

CONVEYOR CONVERTED FOR CRANE LOADING

In one plant making insulating board, an average of 190 cords of wood are handled daily during an 8-hour shift. The storage area consists of two parallel lines of storage having two storage piles in each line and a conveyor and rail siding between

the lines. Wood is received by truck and rail. Each truck hauler unloads his own truck racking the wood in neat lines. Wood delivered by rail goes directly into the conveyor from the cars. Wood is recovered from storage by using one 2-yard Link-Belt crawler crane with 40-foot boom and orange peel grapple. Storage piles are recovered in order of receiving so that an inventory is established each time a pile is finished. About 50% of wood going to process is from storage.

The wood conveyor is not of the loading type but is very narrow, and was originally built for manual loading. Aprons are formed on the sides by wood placed in orderly fashion up against the side of the conveyor top. There is one straight transfer. The one conveyor rises about 9 feet above the receiving chain and the wood drops freely to the chain below.

Before going through a conventional drum-type barker, the wood is sawn into 30-inch lengths. Wood leaving the barking drum discharges onto a 48-inch wide rubber-covered belt which serves as a sorting table. After 4 years' service this belt was in good condition.

Accepted wood from the sorting table leaves the woodyard operation at this point and goes into the process.

A COMBINED LUMBER AND PULPWOOD OPERATION

One mill which has a combined lumber operation receives wood by truck and rail in 16-foot lengths. Wood going into the mill goes to a slasher and is sawed into 5-foot 4-inch lengths before going to the barking drum. Wood is fed to two barking drums from a multi-strand chain with baffle to distribute the wood equally to the two drums. This baffle plate is set on the center line of the conveyor so that half of the wood should go to each side. Uneven distribution of wood on the conveyor, however, causes uneven distribution to the two drums.

SA-150 chain with 18-inch wide conventional flights spaced at 6 feet is used for conveying the wood.

SORTING TABLE

One mill has an elaborate sorting table for handling wood from two barking drums. The sorting table is set on the center line of the two drums, and wood falls onto it from a chute at the end of the drums. The table is composed of C-132 chains side by side without attachments and is approximately 20 feet long and 6 feet wide. Near the inlet end wood dragged off on either side falls into a hopper from which a conveyor returns it to the barking drum inlet. Beyond that point is another hopper into which wood can be dragged from either side from which a conveyor takes it to the older chippers. The main flow of wood is off the end of the sorting table to the new multiknife chipper. Wide platforms extend along each side and over all is a roof to protect personnel. Figure 16 shows the sorting table.

This same mill stores wood jackstraw fashion with railroad tracks between piles and two locomotive cranes putting wood into and out of storage. These locomotive cranes are also used as yard shifters for shifting wood cars. This mill also rotates piles in storage and takes inventory by scaler's records when a pile becomes empty.

CLOSE CLEARANCE TRANSFERS

This same mill has had good results with conveyor transfer points with a minimum distance between discharging and receiving chains, rather than holding this distance greater than lengths of a stick of wood. They use types 8118 and SA-150 chain, with an 18-inch wide trough in the conveyor for the chain attachments and a recess in the center of the trough for the chain itself.

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. . . Using Powdered-Coal Flyash

WALTER H. COBBS, JR.

This discussion and list refer to flyash formed from burning pulverized coal and carried by flue gas to the stack. It is not intended to include other materials of larger particle size and greater carbon content, such as fine cinders. We believe the list includes nearly all the articles and patents of interest that have been taken from major abstract journals up to May 1, 1950.

CONSTRUCTION USES

Using flyash in the large field of Federal construction during 1949 stimulated interest in its further application. Delivery of a total of 140,000 tons of flyash was started at Hungry Horse Dam in Montana. It replaces a large part of Portland cement for the concrete in the dam. Since Hungry Horse will be the fourth largest dam in the world, using flyash there helps to promote the material. Recently the Bureau of Reclamation has decided to use flyash in the Canyon Ferry Dam and power plant.

FLYASH COSTS

Legal requirements (*54*) are becoming stringent on the removal of flyash from flue gas before discharging to atmosphere. Usually ash must be separated and disposed of satisfactorily. This operation is costly.

Walker (*61*) gives results of surveying economics of flyash disposal. He reports that 22 industrial and 52 public utilities collected and disposed of 1,543,195 tons of flyash in 1948 at a cost of $1,025,306. This is an average cost to industrials of 85¢ per ton, to utilities of 66¢ per ton with an over-all average of 67¢ per ton. In addition to disposal costs, the utilities have an investment of about $30,000,000 in equipment for arresting flyash.

Total cost of ash delivered to Hungry Horse Dam is reported as $11.50 per ton, of which $10 is for transportation from Chicago. Even so, the Bureau of Reclamation expects to save more than 1 million dollars on Portland cement replacement alone. One large-scale market seems to be opening up for this material. This market offers promise of allowing disposal costs to be minimized greatly, if not totally eliminated.

CONCRETE CHARACTERISTICS

Handy (*35*) describes use of flyash in concrete by the Chicago District Electric Generating Corp., Chicago Sanitary District, Wisconsin Highway Commission, Kansas State Highway Commission, and the National Concrete Masonry Association.

Most extensive and basic work on flyash in concrete was done by Davis and his associates (*20–25*). Results of their studies and experiences are summarized in his description (*35*) of the effect of flyash on concrete properties. Blanks (*10*) gives similar information in a recent paper. Briefly, water requirement remains unchanged, workability improves markedly, heat of hydration and temperature rise are smaller.

Compressive strength above 70°F. and after 14 days equals or betters that of concrete using no flyash. At lower temperatures more time is needed for flyash concrete to reach comparable strength. Late strength exceeds Portland cement concrete. For ash carbon content of less than 10% the dry shrinkage of flyash concrete is less than that made with a Portland cement material.

With over 2½% air entrainment and 20% flyash cement, resistance to freezing and thawing is about 1.75 times that for standard concrete. Last, but perhaps most hopeful, flyash in concrete appears to reduce greatly the expansion

Walter H. Cobbs, Jr., Southern Research Institute, Birmingham, Ala.

and deterioration of concrete from alkali-aggregate reaction. Further research work is now in progress on this phase of the picture. Other work on flyash used in concrete is given in references (*7*, *14*, *26*, *30*, *34*, *37*, *39*, *40*, *42–47*, *55*, *58–60*, *63*).

OTHER FLYASH USES

Extensive surveys of potentially profitable flyash uses include those of Weinheimer (*63*), Minnick (*46*), Thompson (*59*), and Thorson and Nelles (*60*). Flyash used in concrete was found highly successful in all surveys. Next in importance seems to be in bitumastic (asphalt) road construction as a fine filler. The Detroit Edison Co. disposed of 1200 tons of flyash for this use in 1948 (*64*). Randall (*52*) and Minnick (*46*) describe a promising new development in a high-quality, red vitrified brick. It is similar in appearance to the common shale brick but more uniform, stronger, and less permeable than the usual product by the inclusion of flyash. Standard brick-making equipment may be used for manufacture. Research is under the sponsorship of Philadelphia Electric Co. at G, and W. H. Corson Laboratories.

A superior insulating cement has also been developed (*52*, *70*). Randall (*52*) states that flyash shows promise as a soil-stabilizing agent in road construction. The third-ranking successful use of flyash is in building materials other than concrete (*35a*, *37*, *43*, *46*, *48*, *50*, *62*, *68*). Cottrell block employs 90% flyash and is a successful building block. Other building blocks may be made from flyash combined with slag.

Other applications include use as: an impregnating agent for wood (*9*), a fine blasting sand (*16*), foundry sand (*52*), bleaching clay after acid leach (*55*), raw material to make Portland cement (*58*), heat-resistant paint filler (*66*), in compounding of recording disks (*69*), in asbestos cement (*70*).

PROBLEMS

Significantly, Weinheimer (*64*) has pointed out that acceptance of flyash as a material on a technical basis is only part of the problem. The potential customer may be antagonistic for various reasons. A well-integrated engineering sales program may be a necessity to gain acceptance.

Handling problems are uppermost among the difficulties to be overcome by the customer. For work on these see references (*1*, *6*, *19*, *28*, *29*, *32*, *38*, *56*, *57*, and especially Thompson, *59*).

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Amount of Chipable Waste at Southern Pine Sawmills

ROSWELL D. CARPENTER

This paper summarizes the results of a study of the amount of wood waste, suitable for pulp chips, produced at four different classes of southern pine sawmills. The study, carried out between October, 1948, and February, 1950, was made cooperatively by the Southern Kraft Division of the International Paper Co. and the Southern Forest Experiment Station.

STUDY METHODS

Results were obtained at 16 sawmills in northern Louisiana and in southern and central Arkansas. On the basis of their sawing equipment, the mills were divided into four classes:

Class 1—Band headsaw with resaw.
Class 2—Solid-tooth circular headsaw with resaw and shotgun carriage feed.
Class 3—Solid-tooth circular headsaw with steam feed (small gun); no resaw.
Class 4—Portable mill with circular headsaw using inserted bits; no resaw.

Two mills of each class were in Arkansas and two in Louisiana.

Most of the study logs were loblolly and shortleaf pine. At some of the mills, a few longleaf logs were included. All logs were peeled before sawing. Practically all of the logs came from second-growth timber, and the volume of heartwood was so small that it was included with the sapwood in computing the waste.

At each of the mills, an attempt was made to secure data on waste from the number of logs indicated in the tabulation below. Only one log was obtained in the two largest diameter groups. In the other diameter groups, it was not possible to get the desired number of logs at every mill, but enough were studied to assure statistically reliable results and to give a sound basis for comparisons between classes of mills.*

The procedure for determining the amount of waste was the same at each mill. Logs were peeled by hand and then segregated by diameter groups. For each log the average diameter was taken to the nearest $^1/_{10}$ inch at the small end, middle,

Diameter group, in.	*Scaling diameters included, in.*	*Logs, desired, no.*
6	4.51 to 6.50	20
8	6.51 to 9.50	50
11	9.51 to 12.50	50
14	12.51 to 15.50	50
17	15.51 to 18.50	20
20	18.51 to 21.50	20
23	21.51 to 24.50	5
26	24.51 to 27.50	5
29	27.51 to 30.50	5

and large end. All diameter measurements were taken inside bark with calipers. Length was measured to the nearest

Roswell D. Carpenter, Southern Forest Experiment Station, Forest Service, U. S. Dept. of Agriculture, New Orleans, La.

* Tables of the standard error and standard error in per cent of the mean of the waste in cords by mill classes for Arkansas and Louisiana show fairly consistent results. For all mill classes, the greatest error is in the 8 and 11-inch diameter groups.

1/10 foot with a steel tape. Net Doyle scale, inside bark, was recorded. Logs were reduced in volume for sweep in excess of 2 inches and for rot, fire scars, and other deductible defects; and those under 8.5 inches in diameter were given a scale equal to their length. The volume in cords of waste per thousand board feet has not been adjusted to a base of 16-foot log length because the average log length of both the study logs and those found in a subsequent analysis of the annual log intake closely approached this figure.

The peeled logs in each diameter group were weighed to the nearest 5 pounds.

The logs were put through the sawmill by diameter groups and data were recorded separately for each group. A piece tally of the lumber by length, width, and thickness was made by the sawmill's lumber grader. Six samples of the green wood were taken at random from the sapwood portion of the lumber in each diameter group, and the moisture content was determined by the oven-dry method.

Table I. Waste Production at 16 Study Mills, 1948

Mill class	*Lumber production, M bd. ft. green lumber tally*	*Chippable waste, cords*	*Chippable waste per M bd. ft. cords*
1	32,465	13,992	0.43
2	31,949	14,601	0.46
3	19,218	11,742	0.61
4	15,836	9,676	0.61

All slabs, edging strips, and end trim from each group were collected and weighed immediately after sawing. For at least two mills in each class, the waste was then sorted into chippable and nonchippable material. For the purpose of the cooperators, nonchippable material consisted of thin, ribbon-like pieces of edging strips and all heavier material less than one foot long. The amount of such material varied by diameter classes (see footnote to Table IV) but averaged only 6% of the total heavy waste. Weight or volume of sawdust was not determined. The data on heavy waste were computed in terms of weight and then converted, taking 2500 pounds of oven-dry wood as the equivalent of 1 cord.

Table II. Chippable Waste (in Cords) per M Board Feet, Green Lumber Tally, from Study Logs

Diameter group, in.	*Mill class* 1	2	3	4
6	0.76	0.81	0.90	0.69
8	0.62	0.54	0.77	0.82
11	0.47	0.43	0.46	0.57
14	0.36	0.35	0.33	0.40
17	0.31	0.28	0.29	0.24
20	0.33	0.24	0.27	0.27
23	0.34	0.19	0.26	0.25
26	...	0.14	...	...

This phase of the study gave the volume of waste for the study logs only. In order to determine the total volume of waste produced by the different study mills, it was necessary to determine the log intake pattern (by diameter and length) for the individual mills. This information was obtained from a study of each mill's log scale sheets for each tenth sawing day throughout the first half of 1948.

AMOUNT OF WASTE

The amount of chippable waste produced per thousand board feet, green lumber tally, was 0.43 cord for class 1 mills, 0.46 cord for class 2 mills, and 0.61 cord for mills in classes 3 and 4. In 1948, the average study mill in class 1 or 2 cut about 8000 M board feet of pine lumber, and thus produced about 3500 cords of chippable waste. Class 3 study mills, with an average annual cut of 4800 M board feet of pine, had 2900 cords of heavy waste; and class 4 mills, with only half the lumber output of the class 1 mills, still produced over two thirds as much waste. The volume of chippable waste for the study mills, as calculated from the 1948 log intake records, is shown in Table I.

The main factor governing the amount of waste produced proved to be the diameter of the logs being sawn. Mill class was a secondary influence. The production of waste by log diameter and mill class is shown in Table II.

In mills of all classes, small logs produced the most waste and large logs the least. With a few minor exceptions, the proportion of waste for all mill classes decreased regularly as log diameter increased. Thus, in the log diameter groups between 6 and 23 inches, the waste factors in cords per thousand board feet, green lumber tally, declined from 0.76 to 0.34 cord for class 1 mills; from 0.81 to 0.19 cord for class 2 mills; and from 0.90 to 0.26 cord for class 3 mills. In class 4 mills, the waste factor rose from 0.69 cord in 6-inch logs to 0.82 cord for 8-inch material, but then declined to 0.25 cord at 23 inches.

Table III. Per Cent of 1948 Green Lumber Tally Produced from Logs of Specified Diameter Groups, by Mill Class

Diameter group, in.	*Mill class* 1	2	3	4
6	1.2	2.7	8.1	2.9
8	13.8	33.9	43.7	32.6
11	35.1	41.5	33.6	42.3
14	32.1	17.0	11.0	16.0
17	13.2	4.0	2.5	5.3
20	4.2	0.6	1.0	0.8
23	0.4	0.3	0.1	0.1
	100.0	100.0	100.0	100.0

For most diameter groups, class 2 mills produced less waste than mills of other classes. Class 4 mills produced somewhat more waste than other mills in logs from the 8, 11, and 14-inch diameter groups. These groups are the ones from which all classes of study mills drew the greatest volume of wood.

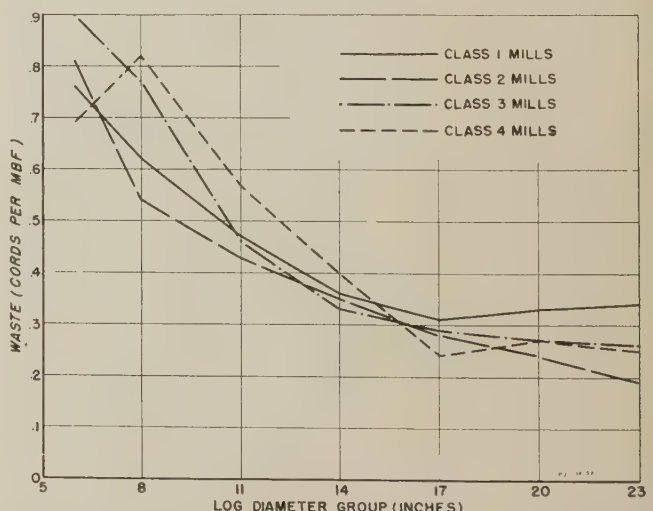

Fig. 1. Average amounts of chippable waste (in cords of waste per M board feet, green lumber tally) produced by study mills

The log intake patterns (the percentages of green lumber tally produced from logs of specified diameter groups) for the mills of various classes are shown in Table III. The table shows that mills in classes 2, 3, and 4 get about 95% of their cut from logs less than 15.5 inches in diameter. Mills in class 1 get only 82% of their cut from logs of these sizes.

As is evident from the overrun figures in Table IV (column

Table IV. Total and Chippable Pine Waste from Study Logs

Diameter class, in. (1)	Mills, no. (2)	Logs, no. (3)	Net scale, Doyle, bd. ft. (4)	Green lumber tally, bd. ft. (5)	Overrun, based on green chain lumber tally, % (6)	Total waste,[a,b] cords (7)	Total waste per M bd. ft.[b] Doyle scale, cords (8)	Total waste per M bd. ft.[b] Green lumber tally, cords (9)	Chippable[b,c] Total chippable, cords (10)	Chippable[b,c] Waste per M bd. ft. Doyle scale, cords (11)	Chippable[b,c] Waste per M bd. ft. Green lumber tally, cords (12)
					Class 1 Mills						
6	2	53	782	763	−2	0.60	0.76	0.78	0.58	0.74	0.76
8	4	197	3,713	6,943	87	4.45	1.20	0.64	4.27	1.15	0.62
11	4	205	9,288	14,611	57	7.29	0.78	0.50	6.93	0.75	0.47
14	4	201	18,125	24,596	36	9.41	0.52	0.38	8.75	0.48	0.36
17	4	93	14,212	16,669	17	5.73	0.40	0.34	5.22	0.37	0.31
20	4	41	9,211	10,142	10	3.68	0.40	0.36	3.35	0.36	0.33
23	2	7	2,187	2,179	0	0.82	0.38	0.38	0.75	0.34	0.34
Total or average	...	797	57,518	75,903	32	31.98	0.56	0.42	29.84	0 52	0.39
					Class 2 Mills						
6	3	48	678	755	11	0.63	0.93	0.84	0.61	0.90	0.81
8	4	251	4,652	9,297	100	5.27	1.13	0.57	5.06	1.09	0.54
11	4	226	9,725	14,919	53	6.70	0.69	0.45	6.36	0.65	0.43
14	4	167	14,796	18,312	24	6.94	0.47	0.38	6.45	0.44	0.35
17	3	35	4,896	5,664	16	1.72	0.35	0.30	1.56	0.32	0.28
20	2	19	3,812	3,862	1	1.00	0.26	0.26	0.91	0.24	0.24
23	2	4	1,147	1,147	0	0.24	0.21	0.21	0.22	0.19	0.19
26	1	1	331	301	−9	0.04	0.14	0.15	0.04	0.12	0.14
Total or average	...	751	40,037	54,257	36	22.53	0.56	0.42	21.21	0.53	0.39
					Class 3 Mills						
6	4	76	1,159	1,480	28	1.37	1.18	0.92	1.32	1.14	0.90
8	4	287	5,195	8,957	72	7.21	1.39	0.80	6.92	1.33	0.77
11	4	230	9,686	13,520	40	6.52	0.67	0.48	6.19	0.64	0.46
14	4	156	13,667	16,079	18	5.66	0.41	0.35	5.27	0.38	0.33
17	4	62	9,056	9,701	7	3.09	0.34	0.32	2.81	0.31	0.29
20	3	47	10,006	10,156	1	3.04	0.30	0.30	2.77	0.28	0.27
23	2	5	1,498	1,370	−9	0.40	0.26	0.29	0.36	0.24	0.26
Total or average	...	863	50,267	61,263	22	27.28	0.54	0.44	25.64	0.51	0.42
					Class 4 Mills						
6	2	37	510	693	36	0.49	0.96	0.70	0.48	0.94	0.69
8	4	252	4,361	7,750	78	6.64	1.52	0.86	6.39	1.46	0.82
11	4	212	8,849	12,620	43	7.60	0.86	0.60	7.23	0.82	0.57
14	3	105	8,574	10,542	23	4.56	0.53	0.43	4.24	0.50	0.40
17	3	23	3,113	3,497	12	0.94	0.30	0.27	0.86	0.28	0.24
20	2	22	4,122	3,977	−4	1.16	0.28	0.29	1.06	0.26	0.27
23	1	6	1,542	1,354	−12	0.37	0.24	0.27	0.34	0.22	0.25
Total or average	...	657	31,071	40,433	30	21.76	0.70	0.54	20.59	0.66	0.51

[a] Moisture content of all material in this study was 50.51% of green weight and varied between extremes of from 34.73 to 61.34%. Calculated by the lumberman's method, the moisture content of all material was 102.05 and varied between extremes of 53.20 and 158.66.
[b] Minor discrepancies between means and totals are due to the fact that sufficient significant digits are not carried in the means.
[c] The proportion of total waste that was chippable was 97% for 6-inch logs, 96% for 8-inch logs, 95% for 11-inch logs, 93% for 14-inch logs, and 91% for 17+-inch logs. For all study logs combined, the proportion was 94%.

6), mills in classes 1 and 2 usually get more lumber from a log of given diameter than do the mills in classes 3 and 4. This extra output stems from the fact that class 1 and 2 mills have thinner headsaws as well as resaws, and therefore cut less kerf than mills in the other classes. In evaluating the performance of the class 1 mills, it should also be remembered that they cut more 1-inch boards and less 2-inch dimension lumber than class 3 and 4 mills.

Figure 1 charts the performance of the various mill classes on logs of different diameter groups. Table IV gives factors for total waste and other information on the study logs.

APPLICATION OF RESULTS

The waste factors developed in this study may be used to predict, with reasonable accuracy, the production of total heavy wood waste at most mills cutting southern pine timber. The steps in calculating wood waste are:

1. Place mill in its appropriate class.

2. Determine the percentage of annual log intake that comes from each of the diameter groups used in the present study. The records for every tenth sawing day for 6 months, or for every twentieth sawing day for a year, should be adequate for this purpose. The proportions of log intake should be expressed in percentage of green lumber tally from logs of the different diameters.

Suggested steps in doing this are: (a) determine for the above period the log scale for logs of the various diameter groups; (b) use the average overrun percentage figures (based on green chain lumber tally) per diameter group as shown in Table IV (column 6).

3. Multiply the per cent of the lumber tally in each diameter group by the factor for total waste for that group as given in Table IV (column 9).

4. The sum of these figures is the weighted amount of waste per thousand board feet of lumber produced during the sample period.

5. Multiply the weighted average amount of waste per thousand board feet by the total annual output of the mill.

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Instrumentation Studies. LXVIII. Evaluation of Dirt in Paper

I. Discussion of Methods for Speck Counting and Analysis

O. HARRY OLSON

It is generally agreed among manufacturers and consumers of paper that present methods of evaluating "dirt in paper" are too subjective and inadequate. More objective methods would seem desirable. Also, since the evaluation of dirt often depends upon the use for which paper is destined, different methods might be required for different types of paper or different uses of the same paper. Many mills have devised their own methods for evaluating dirt to fit their own needs but, at this time, TAPPI recognizes only one standard method. It is the purpose of this study to critically evaluate known or published existing methods. Underlying principles will be discussed and their application to a method pointed out. In so doing it is hoped that a more objective and adequate method of dirt analysis may be evolved.

A representative method of dirt analysis is afforded by TAPPI Standard T 437 m-43 based on Clark's method (*6*). Consideration of some of the features of this special case will furnish a basis of our discussion. This method is designated "tentative," which implies that its authors did not consider it entirely satisfactory. This method defines dirt as follows: "Dirt in paper is any foreign matter imbedded in a sheet of paper which has a marked contrasting color to the rest of the sheet when viewed by reflected light and which has an area of 0.04 sq. mm. or more." The method evaluates dirt of all colors in terms of an equivalent black area. Spots which appear dark only when seen by specularly reflected light are not considered dirt. *Equivalent black area* is defined as the area of a black spot on a white background which would make the same visual impression as does the spot itself on its particular background. Consequently, according to the method, the estimated equivalent black area of a gray or colored spot would be smaller than its actual area in inverse proportion to the intensity of its color. The method calls for illumination of the sample by an incandescent bulb and the use of a standard chart (*5*) containing a series of small areas for estimating the areas of dirt spots.

1. Probably the most frequently cited criticism of this method is the difficulty of estimating the equivalent black area of a nonblack spot. This calls for a subjective evaluation of the "intensity" of the color of a spot and applying it so as to reduce the actual area to an "equivalent black" area. One would not expect very good reproducibility in this type of process.

2. Reflected light can be expected to yield meaningful results only for papers which are destined to be viewed by reflected light. One would not expect tracing paper, glassine, parchment, etc., which are usually viewed by transmitted light, to be best analyzed by reflected light. Some "dirt" which is invisible by reflected light will show by transmitted light. An example would be localized high density spots of the base material. These will show by transmitted light because of their greater opacity but they will be invisible by reflected light because their color is the same as that of the base material.

3. The TAPPI Standard specifies 0.04 sq. mm. as the minimum speck to be considered. This, of course, is a very arbitrary figure and cannot be expected to hold for all types and grades of paper. For some finer grades of paper, it might be smaller and for some coarser papers, it could be much larger. In order that a standard method be applicable to different grades of paper, it would seem advisable to set up a different minimum speck size for each of several different types or grades.

4. The TAPPI Standard rules out those specks which are visible by specularly reflected light only. This refers to colorless shiny spots which are visible by specularly reflected light in some one direction. The use of the paper tested should be considered in deciding if such specks should or should not be included in a count.

5. The TAPPI Standard specifies that a 50-watt Mazda frosted lamp be used at a distance of 4 feet from the sample. It does not specify the angle of illumination or viewing, or the distance of viewing. These are certainly conditions which have an effect on the visibility of specks. Graff (*1*) specified a chin rest for the observer to keep the viewing distance approximately fixed. Angular as well as linear location of the light source should be specified. The color temperature of the source may be sufficiently well defined by the wattage rating and type of lamp in most cases, but voltage has not been specified and this may vary the intensity considerably. A careful specification would include tolerances for the voltage and age (or condition) of the lamp.

6. The specifications for a standard method of analysis should include sampling directions. Simmonds, et al. (*2*) developed a system of sampling which has proved reliable and which greatly reduces the time involved in running an analysis.

7. Even with all of the physical conditions controlled and held reasonably constant as outlined in the fore-

O. Harry Olson, Research Assistant, The Institute of Paper Chemistry, Appleton, Wis.

going discussion, there remains in a visual method the personal equation—the problem of individual differences among observers. Graff (*1*) reported reproducibility within 10% for a single observer and within 20% for two observers. The latter figure is, presumably, for two observers trained in the same laboratory by the same supervisor. The agreement between observers trained by different supervisors is not known but, presumably, it would not be as good. One test of a method should be the ability of different observers to agree within preassigned tolerances. To meet this requirement, a test should be free of as many arbitrary and subjective features as feasible.

Because of the difficulties inherent in a visual method, an instrumental method should be considered. A suitably designed photoelectric device for scanning a surface for "dirt" should have many advantages over present methods.

Adrian and Graff in 1940 (*7*) and Graff in 1947 (*1*) made comparative evaluations of different methods of dirt count in pulp and paper. They demonstrated the effects of most of the variables discussed in the foregoing portion of this report. Their work and findings might well furnish the background for an instrumentation study on dirt count.

The general problem is to find the number of dirt specks and the area of the dirt specks in a given area or weight of paper or pulp. Usually, some classification of specks by size is desirable, such as small, medium, and large. In addition to size classification, identification and classification according to source or chemical nature are also often desired.

The best known counting and size classification methods are the TAPPI Standard [Clark's method (*6*)], Graff's method (*1*), and the method of Simmonds, et al. (*2*). These depend on visual counting and estimation of the area either by reflected or transmitted light, or both. *Area*, in these methods, is estimated either by comparison with a standard chart (*5*) or by means of an eyepiece micrometer.

Browning and Graff (*4*) have prepared a chart which classifies dirt as to source as follows: (a) raw material dirt, (b) process dirt, (c) mill dirt. Raw material dirt is subdivided into dirt from wood, rags, and added materials. The identification of specks is determined by three distinct characteristics—physical properties, solubility, and chemical tests. The most common sources in each classification are listed in convenient form and opposite each are given the physical properties, solubility tests, and chemical tests for easy reference. It is stated that most of the commonly occurring specks can, as a rule, be identified by a trained observer using a microscope of 50 to 100 magnification with transmitted light.

Dalton and Wiltshire (*3*) have prepared a system of identification similar to that of Browning and Graff in many ways, but differing in approach. They first classify a speck in one of two main groups depending on whether it is opaque or transparent. It is then further assigned to a subgroup depending on its physical properties. A different testing procedure is outlined for each subgroup. Like Browning and Graff's method, this also is presented in outline form for convenience in use.

FUTURE WORK

Further experimental work in this area should be based on a thoroughgoing study of the literature on the psychophysical factors involved in the "noticeability" and "visibility" of objects. In addition, experimental work of an objective nature should be done on the noticeability and visibility of actual specks in paper.

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Paper and Packaging Specifications

U. S. Government Specifications

Following is information from B. W. Scribner, National Bureau of Standards, Chairman, Technical Committee on Paper and Paper Products, Federal Specifications Board, on Federal specifications of recent issue:

Tape, Teletype, Perforator, Paper, UU-T-120 (New); Price, 5 Cents

The requirements for this paper were formerly contained in Federal Specification UU-P-547, to which reference should be made for specification of the other types of teletype paper used by the Government. The important changes in the requirements are increase in ash content and tensile strength, reduction in minimum oil content, and requirements for grit content and acidity (pH) added.

Pockets and Wallets, Paper (File), UU-P-671 (New); Price, 5 Cents

Requirements are given for the expanding type of file folders, commonly termed "red-rope folders." The requirements include basis weight, thickness, bursting strength, tearing resistance and fiber composition of the papers, and details of construction.

Cards, Guide, Card-Size, UU-C-76c (Revision); Price, 5 Cents

Cards composed of paper of 500-pound (24 × 36—1000) basis weight were deleted as paper of this weight is not considered necessary for cards of this size. Changes were made in the tab cuts and tab printing.

(Copies of Federal specifications and the Federal Specifications Index may be obtained on application accompanied by postal note, money order, coupon or cash to the Superintendent of Documents, Government Printing Office, Washington 25, D. C. The price of the Index is 35 cents.)

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CONSTRUCTION MATERIALS IN THE PAPER INDUSTRY

Part I—Stock Handling

Lead

Kempton H. Roll

One of the important chemicals utilized in the paper industry and, more particularly, in stock handling, is alum. Papermaker's alum is aluminum sulphate, $Al_2(SO_4)_3$ 14.5 H_2O, a chemical which is corrosive to practically all of the common materials of construction with the exception of lead and its alloys, antimonial lead and tellurium lead. It is used either in dry form or as a liquid solution 40 to 50% concentration at about 35° Bé. (liquid alum).

Alum is introduced in the stock beater or jordan, or both, to produce coagulation and fiber coating. It is added along with a sizing agent consisting of either a soap made from saponifying rosin with alkali or a wax emulsion. Alum precipitates the size so that a gelatinous film is deposited on the fiber. After water of hydration is removed, the paper produced has a hardened surface that resists penetration by liquids. Alum is also used to neutralize alkalinity of pulp and water, to help pigment and filler retention, and to reduce pitch and sticking. Raw water is treated in the filter plant with alum to remove turbidity and color. In the pigment plant it is used with lime to make satin white.

Lead has for many years and continues to be used in both the manufacture of alum as well as the handling of the finished product in storage and in use. Upon contact with lead, alum immediately forms a thin protective film consisting essentially of lead sulphate. It is this impenetrable and strongly adherent film which successfully prevents any further reaction with the lead. It is important to note that after a very brief exposure to alum all corrosive action ceases. This assures retention of adequate thickness since lead corrodes uniformly over its entire exposed surface and not by localized pitting. Furthermore this assures complete freedom from the introduction of any harmful products of corrosion into the pulp stock. This latter advantage is particularly significant in the making of fine paper where absolute freedom from many chemical impurities is imperative.

Lead is used wherever liquid alum is encountered alone in (1) storage vessels, (2) conveying lines, (3) feed tanks, and (4) measuring boxes.

Examining each of the above applications individually, storage vessels are lined with sheet lead. Vessel dimensions depend entirely upon the alum consumption of the particular plant and may be of lead-lined vessels constructed of concrete, brick, wood, or steel. Another type of construction may consist of a skeleton steel framework supporting sheet lead. Brick or concrete tanks are first lined with $^1/_{16}$ to $^1/_8$-inch asbestos sheet to protect the lead from abrasion and any effects of "green" concrete. Lead linings may vary in thickness from 8 to 12 pounds ($^1/_8$ to $^3/_{16}$ inch). For storage purposes where severe temperature fluctuations are not normally involved and where the vessels are not more than 10 feet high supporting straps for the lead are seldom employed. The lead sheet is merely anchored around the top edge and hung over into the vessel in such a manner that the weight is supported by the lip and the bottom.

Alum conveying lines are of lead pipe whose size again depends upon the volume of alum being handled: $1^1/_4$-inch with $^1/_4$-inch wall to 3-inch lead pipe with $^3/_8$-inch wall is commonly used. Over long spans it is almost universal practice to lay the pipe in angle iron or channel iron supports. Cast solid lead valves and pumps or lead-lined valves and pumps may be used to control the alum flow. Joints between pipe sections may be of the Van Stone type or "split joints" welded (burned) together by a properly qualified lead burner.

From storage the alum is usually pumped through lead pipe to an auxiliary storage or feed tank located at the high point of the beater room. A float switch is sometimes installed to control the pump automatically to maintain proper alum level. A typical 500-gallon capacity tank is constructed of steel loose-lined with 8-pound sheet lead. From the feed tank the alum flows by gravity through lead pipe to the measuring boxes.

Lead measuring boxes are used to furnish measured amounts of alum to the stock and are often suspended above each beater. One system, and probably the oldest, is to make the liquid alum directly in the measuring box by dissolving dry lump or powdered alum in water heated to 120 to 140°F. The dry alum is lowered in a perforated wooden basket into the lead box containing the hot water where it remains until all of the alum is dissolved. Boxes may be emptied by either gravity feed directly to the beater or by steam jet siphon. A box for this purpose may consist of a wooden frame 2 by 2 by 2 feet lined with 8-pound lead. All of the seams are welded (burned) using burning bar of the same composition as the lining which may be chemical lead or antimonial lead.

Newer systems use liquid alum at the outset and thus entirely eliminate the necessity for handling and dissolving dry alum. A typical mill receives the liquid alum delivered to the plant by tank truck through lead pipe and stores it in an 18,000-gallon 10-pound sheet lead-lined reservoir. From here it is pumped through 3-inch lead pipe to a 500-gallon 10-pound lead-lined feed tank located above the beater room; the alum flows through 2-inch lead pipe to 10-pound lead-lined measuring tanks and thence directly to each beater. No problems due to alum crystallization at any stage in the system have arisen in any of the mills investigated. This method of handling alum apparently offers sufficient advantage in economy and efficiency over dry alum methods to convert a number of paper mills into installing new liquid alum equipment.

Ferric sulphate may be used as an alum substitute for sizing in the beater or as a water coagulant to remove turbidity and color from raw water in the filter plant. Lead is specified wherever ferric sulphate solution is encountered because this chemical is not only acid but also is oxidizing.

Sulphuric acid is another chemical used occasionally in stock handling which, of course, requires lead for corrosion protection. Sulphuric acid is used for wire souring, parchmentizing, and pH adjustment.

Another application of lead in stock handling is for covering agitator shafts found in stock chests and "knotters." Agitator blades are made of cast iron which is sufficiently resistant to the acid sulphite stock (about pH of 5) but too brittle and

Kempton H. Roll, Lead Industries Association, New York, N. Y

too expensive to be cast into shafts; therefore the shafts are made of steel. But since acid stock rapidly attacks steel it has been necessary to cover the shaft itself with 4 to 6-pound lead to protect and preserve it. Typical shafts are 3 to 4 inches in diameter and 20 to 30 feet long.

Because of the abrasion involved, the vessels themselves are usually constructed entirely of acid-resistant brick. When a steel shell is lined with brick it is customary to first line the steel with a sheet of lead to prevent attack of the steel by acid seepage through the brick.

For stock preparation and handling wherever alum is used, lead has found extensive and increasing application. Employed chiefly for its excellent resistance to the corrosive attack of alum, lead is also used for other reasons. It has proved to be one of the easiest materials to keep clean; it gives extremely long service; it can be repaired in place.

The latter characteristic is especially important for when repairs are necessary they may be easily accomplished with a minimum of expense and shutdown time. In addition, lead is not valueless after its useful service life or obsolescence of the equipment; it may always be salvaged at the highest return of any of the common corrosion-resistant materials.

Monel, Nickel, Inconel, and Ni-Resist

H. O. Teeple

Many materials of construction have been used for stock handling in the past, some have proved to be satisfactory and others have not. The modern trend appears to be toward those materials which possess certain favorable characteristics some of which are good strength, ease of fabrication and erection, availability in desirable sizes and forms, good resistance to corrosion, and an initial cost which can be economically justified.

Table I. Corrosion of Primary Sulphate Brown Stock Washer Headbox

Plant test for 32 days, stock at 190°F.

Material	*In./yr.*
Monel	0.0005
Nickel	0.0034
Inconel	<0.0001
Ni-Resist	0.0014

Monel, nickel, Inconel, and Ni-Resist are materials of construction which possess many of these favorable characteristics desired for stock handling. Of these materials, Monel and Ni-Resist are the most widely used. Nickel, generally speaking, has no appreciable advantage over Monel from the standpoint of corrosion resistance and, consequently, its use is limited to some extent because of its slightly higher initial cost. In some cases, however, the use of nickel in the form of plated equipment will offer economical advantages.

Table II. Corrosion of Secondary Sulphate Brown Stock Washer Headbox

Plant Test for 32 Days, Stock at 135°F.

Material	*In./yr.*
Monel	<0.0001
Nickel	<0.0001
Inconel	<0.0001
Ni-Resist	0.0010

Inconel finds its primary application in slotted screen plates. Its resistance to corrosion by paper stocks is quite high, of the order of 0.0001 i.p.y. or less. Its resistance to slot wear is also quite high, which is an important characteristic. In addition, service life records indicate Inconel possesses a high degree of resistance to fatigue, superior to other materials commonly used for slotted screen plates.

Table III. Corrosion of Primary Soda Brown Stock Washer Headbox

Plant Test for 158 Days, Stock at 180°F.

Material	*In./yr.*
Monel	<0.0001
Ni-Resist	0.0025

Ni-Resist is used for pumps, value, and cylinder spiders all the way through the stock-handling operation. Ni-Resist is superior to cast iron in corrosion resistance and is comparable to or better than that of the commonly used cast bronzes.

Table IV. Corrosion of Groundwood Knotter Screen

Plant Test for 61 Days, Stock at 103°F.

Material	*In./yr.*
Monel	0.0008
Nickel	0.0004
Inconel	<0.0001

Monel, by virtue of its many favorable charactersitics desirable for stock handling finds wide usage in the paper industry. In the following discussion of practical applications of Monel, corrosion data are shown illustrating the usefulness of Monel. Data are also shown, when available, for nickel, Inconel, and Ni-Resist for comparison and information purposes.

Table V. Corrosion of Sulphite Headbox to Knotter Screens

Plant Test for 75 Days, stock at 44°F., pH 4.3

Material	*In./yr.*
Monel	0.0017
Nickel	0.0079
Inconel	<0.0001
Ni-Resist	0.0087

Monel has been used extensively in the past in diffusers and blow pits in the alkaline pulping industry. In recent years, since brown stock washers have largely replaced diffusers, Monel has been widely used for these stock washers. The resistance of Monel to corrosion by the alkaline liquors together with its strength and availability in useful forms have accounted for its popularity for stock washers. That Monel is suitable for brown stock washer construction, the data in Tables I, II, and III are illustrative.

Table VI. Corrosion of Soda Screening Headbox

Plant Test for 59 Days, stock at 70°F., pH 5.3

Material	*In./yr.*
Monel	0.0010
Nickel	0.0010
Inconel	<0.0001
Ni-Resist	0.0023

Screening is done to remove the small percentages of coarse and irregular particles of stock as well as to remove foreign substances. This is frequently done by rotating cylindrical screens. That Monel is useful is illustrated by Tables IV, V, and VI.

H. O. Teeple, International Nickel Co., New York, N. Y.

Table VII. Corrosion by Groundwood and Sulphite Stock Thickener Filtrate

Plant Test for 60 Days, Stock at 115°F., pH 4.6

Material	*In./yr.*
Monel	0.0025
Nickel	0.0002
Inconel	<0.0001

Monel is also quite suitable for rifflers, fine screens, deckers, and thickeners. In connection with the latter, usually of cylinder mold construction, Monel has found considerable application for structural rods, winding wire, backing, and facing wires. Corrosion data illustrating the usefulness of Monel appear in Tables VII and VIII.

Table VIII. Corrosion of Bleached Sulphite Riffler Headbox

Plant Test for 97 Days, Stock at 68°F., pH 7.0

Material	*In./yr.*
Monel	<0.0001
Nickel	<0.0001
Inconel	<0.0001
Ni-Resist	0.0032

The use of Monel in beater applications, such as beater bars and bed plates, has proved to be quite extensive and corrosion data illustrating this use appear in Tables IX and X.

Table IX. Corrosion of Sulphite Stock Beater Chest

Plant Test for 84 Days, Stock at 63°F., pH 4.7

Material	*In./yr.*
Monel	0.0009
Nickel	0.0021
Inconel	<0.0001
Ni-Resist	0.0054

In the course of further stock refining, Monel has been used extensively for jordan fillings. The corrosion data in Table XI illustrate these applications.

Table X. Corrosion of Sulphate Stock Beater Chest

Plant Test for 98 Days, Stock at 46°F., pH 7.9

Material	*In./yr.*
Monel	<0.0001
Nickel	<0.0001
Inconel	<0.0001
Ni-Resist	0.0032

As in the case of beaters, jordan filling materials must provide adequate resistance to corrosion and possess the hardness and toughness necessary to refine and beat the stock properly. Monel jordan fillings and beater bars are available in hardness ranges from 165 Brinell to over 275. Where maximum mechanical properties are required heat-treatable "K" Monel is the preferred material.

Table XI. Corrosion of Jordan Stock Chest

Plant Test for 76 Days, Stock at 84°F., pH 6.0

Material	*In./yr.*
Monel	0.0002
Nickel	0.0002
Inconel	<0.0001

In paper machine applications, Monel over the course of many years has proved itself to be quite useful for many of the paper machine parts, such as headbox linings, slices, aprons, flow eveners, saveall trays, suction boxes, breast and other roll coverings, table rolls, wire return and guide rolls. The high strength of Monel together with its ease of fabrication and corrosion resistance are responsible for these important applications of Monel.

Table XII. Corrosion of Paper Machine Parts Handling Groundwood and Sulphite (Newsprint)

Plant Test for 209 Days, Stock at 95°F., in White Water Box on No. 3 Machine

Material	*In./yr.*
Monel	0.0002
Nickel	0.0002
Inconel	0.0001

In addition to Monel, nickel in the form of plated equipment has found much use for table rolls, wire return and guide rolls. Nickel plating also has been used to reclaim worn rolls by applying a plate of from 20 to 50 mils of nickel.

Table XIII. Corrosion of Savealls, Sulphite Pulp

Plant Test for 84 Days, Stock at 62°F., pH 4.7

Material	*In./yr.*
Monel	0.0002
Nickel	0.0007
Inconel	<0.0001

Duranickel, a nickel alloy hardenable by heat treatment, has been used for machine shaker springs. This alloy combines high mechanical strength and spring properties together with good resistance to corrosion, all of which are desirable for paper machine shaker springs.

Corrosion data illustrating the usefulness of Monel and nickel for parts of paper machines are shown in Tables XII, XIII, and XIV.

Table XIV. Corrosion of Machine Headbox, Sulphate Pulp

Plant Test for 43 Days, Stock at 90°F., pH 6.8

Material	*In./yr.*
Monel	0.0002
Nickel	0.0001
Inconel	<0.0001

In addition to those applications listed above, Monel has found particular use as stock lines. The many favorable characteristics of Monel are quite desirable stock line material, assuring long life and product purity.

Monel doctor blades are used in many mills and in particular "K" Monel because of the outstanding mechanical properties developed through heat treatment. "K" Monel doctor blades operate with minimum regrinding, absence of metallic beads along the blade edge, absence of a roughened blade surface due to corrosion, absence of rusting which can cause damage to the roll surface, and work equally well at the wet or dry end of the paper machine.

Other important applications of Monel are shower pipes, nozzles, and other miscellaneous uses requiring good resistance to corrosion by paper stock and white waters.

In conclusion it is to be noted that Monel, nickel, Inconel, and Ni-Resist find many uses in the pulp and paper industry. Service life data indicate that these useful materials are easily justified in many instances.

Worthite

W. E. Pratt

Paper stock pumps over a long period of years were

W. E. Pratt, Worthington Pump and Machinery Corp., Harrison, N. J.

usually standard cast iron or cast iron standard-fitted (bronze impeller, rings, and sleeves). In recent years there has been a trend to reduce the heavy metal impurities by using more corrosion-resisting materials in some or all of the stock pumps. All bronze stock pumps are becoming more common in the sulphite mills. The higher cost of chrome-nickel stainless or nickel-chrome-moly alloys does not seem to be justified.

In the kraft pulp mills the highly alkaline solutions prohibit the use of bronzes and the chrome-nickel or nickel-chrome-moly alloys are being used to an increasing extent. The paper stock pumps used for transferring stock from blow tank to washers is the most corrosive condition, except in bleaching. Pumps have been used with cast iron and nickel-cast iron casings with stainless internal parts. A few plants have gone to Ni-Resist Type I casings with suitable stainless trim. One mill has gone to all stainless stock pumps.

These moves toward more corrosion-resisting pumps are all pointed toward reducing metal contamination in the stock in order to improve the grade of paper. While Worthite is a high-alloy stainless steel (24% nickel, 20% chromium, 3% moly, with small amounts of silicon, copper, and manganese) the added corrosion resistance at around 15% higher cost than 18–8 stainless, has not yet been justified in these applications for stock handling.

Worthite pumps are used very widely in the handling of acid sulphite liquors and in the recovery processes in the alkaline pulping mills. These economical applications will be discussed later under the proper subjects.

Cements

Raymond B. Seymour

Litharge-glycerol cements have been used whenever possible for the joining of tile throughout the entire paper industry but is being gradually replaced by more modern cements. Tile in concrete blow tanks have been joined with both phenolic and furfuryl alcohol cements. In standard construction, tile are first joined with Portland cement with is partly raked out and acidified before pointing with the resin cement.

However, the introduction of an extremely fast-setting furfuryl alcohol cement has made possible a new technique in which the leading edge of the tile is joined with the furfuryl alcohol cement before the addition of Portland cement to the back joint. Stainless steel bolts are built into the floor to support a stainless steel false bottom.

Tile linings are also used for storage chests, beaters, blending chests, white water tanks, machine chests, and wire pits. The cement used will depend upon the pH of the stock. Silicate cements have been used throughout the paper industry but are not satisfactory for neutral or alkaline solutions. Sulphur cements are suitable for calcium bisulphite at temperatures below 200°F. Furfuryl alcohol cements are more resistant than phenolic cements to alkaline conditions and are being more favorably considered for new installations and the repair of present equipment. As the new fast-setting furfuryl alcohol cements and associated construction techniques become standard, considerable improvement in paper industry construction may be expected.

Iron and Steel

Arthur E. May and Albert W. Spitz

Cast iron and carbon steel have been used extensively in the stock-handling systems of paper mills. Some corrosion, however, does occur, also discolorization of the stock; the newer mills have in many places substituted more resistant materials. Difficulties encountered from rust and slime in pipe lines have tended to minimize the use of steel piping.

Cast-iron surfaces, unmachined, have an inherent corrosion resistance that is widely used since it is still generally the most economical material of construction. The major equipment in the stock-handling system and the use of iron and steel in its construction are herewith listed:

1. Pulpers and breaker-beaters: Cast-iron bowls and tubs are satisfactory. Tile and concrete are also used.
2. Storage chests: Steel chests have been used but the contamination is usually objectionable. Cast iron, tile, and concrete are satisfactory.
3. Stock and white water pumps: Cast-iron, bronze-fitted pumps are used. Cast-iron bases are sometimes preferred to steel.
4. Refining equipment: High-carbon steel cutting elements with wood spacers have been used; more resistant alloys are now also widely employed, particularly for the better papers.
5. Screening and stock cleaning equipment: Iron and steel have been largely replaced with other materials of superior corrosion resistance.
6. Headboxes: Cast iron has been used on small machines, clad or coated steel boxes are extensively used at present on large, high-speed machines. Wood is also satisfactory.
7. Fourdrinier section: Cast iron is used for framework, bearing brackets, and other structural parts. Unprotected steel is usually unsatisfactory.
8. Piping: Steel pipe with cast-iron fittings has been extensively used; however, scaling, pitting, and slime formation frequently occur. Lined steel pipe has proved satisfactory as has pipe of stainless steel, nonferrous metals, and asbestos cement.

Rubber

James P. McNamee

Rubber linings are used extensively in paper mills because natural rubber and the various types of synthetic rubber are chemically resistant to acids, alkalis, and salt solutions. Moreover, rubber can be adhered to rigid and irregular surfaces to form a protective covering which will resist abrasion and wear in addition to chemical attack.

In the handling of paper stock, rubber linings should be considered for tanks, pipe, fittings, fans, duct-work, agitators, and pumps. This is particularly important for chorinated paper stock in order to prevent contaminating the stock and injuring the color of the paper. All internal parts of pumps which are exposed to the stock should be rubber covered. A semihard or hard natural rubber composition is generally used for these applications, although soft rubber is more abrasion resistant and is recommended when abrasive solids are present.

The rubber lining manufacturer has a wide range of synthetic rubbers as well as natural rubber to use in designing lining compositions. Natural rubber is regarded as the general-purpose lining material because of its ease of handling and wide application, but each of the different types of synthetic rubber possess certain properties which may be utilized for specific applications. As examples we might mention the oil resistance of neoprene which makes it suitable for handling gasoline and machine oil. The Buna N types of synthetic rubber which include Paracril and Hycar, are still more resistant and may be used in contact with animal and vegetable oils. Butyl rubber is not affected by strong oxidizing agents and may be used as protection against strong concentrations of nitric, chromic, and sulphuric acids and strong

Raymond B. Seymour, The Atlas Mineral Products Co., Mertztown, Pa.
Arthur E. May, Moore and White Co., Philadelphia, Pa., and Albert W. Spitz, Reiter Engineering Co., Philadelphia, Pa.

James P. McNamee, U. S. Rubber Co., Providence, R. I.

dichromate solutions. All rubber linings are "tailor-made" from these basic materials for the particular application.

If paper stock is allowed to remain in rubber-lined equipment as a result of intermittent production or between short runs, it will not become discolored and introduce contamination into the system when production is resumed. Slime formation is retarded to a considerable extent and in some cases eliminated completely by rubber linings. Many installations of hard rubber lined pipe have more than justified their original cost on the basis of slime control alone.

Rubber linings should be considered for storage tanks for the many corrosive chemicals used in connection with the handling and treatment of paper stock, as, for example, alum solutions. Pipe and pumping equipment used with these solutions should also be protected with rubber linings.

The new solid plastic pipe fabricated from materials of the Uscolite and Saran types is a particularly important development and should be seriously considered for paper mill application. This pipe is resistant to most acids, alkalis, and salt solutions. It is not affected by chlorine solutions or chlorinated paper stock and its smooth surface should minimize slime formation. An additional advantage is the fact that since the pipe is solid plastic, the outside surface requires no protection against corrosion or slime growth and should go far toward maintaining a clean appearing mill.

Coatings

Kenneth Tator

Current use of organic coatings and coverings in the production and handling of paper pulp is principally for three purposes: to impart cleanliness to all operations, to prevent deterioration of equipment by corrosive agents, and to provide resilient cushioning where required.

Cleanliness of all operations from the blow tanks on is imperative as fine dust or dirt contamination of the pulp will be carried through into the finished paper product. Bacterial slime which will normally build up in white-water handling lines and other equipment will not only reduce the capacity of these lines and equipment, but detached pieces of such slime will be carried with the pulp slurry onto the papermaking machine resulting in a weakness and lowered quality.

After washing of the cooking liquors from the pulp, and with the exception of bleaching operations with are separately discussed, corrosion of equipment is principally due to pitting caused by the use of dissimilar metals, by local cell action caused by oxygen or concentration cells, and by normal iron rust formation. In addition to the gradual deterioration of equipment, such corrosion will produce pits or irregularities in surfaces which must, for quality production, remain of uniform smoothness. Table and couch rolls and weir gates are examples.

Resilient cushion is required of squeeze and take-off rolls for pulp washers and is of advantage in many applications on the wet end of the paper machine, and is desirable wherever resistance to impact or abrasion is required.

All stock-handling operations between the blow tanks and the drying cylinders of the paper machine are conducted at temperatures below 160°F., and therefore choice of coatings or coverings is determined by chemical and physical properties other than thermal limitations.

For use in pulp and paper production the organic protectors may be divided into three classes, according to thickness: thin films, of the order of thickness of usual paint films, 3 to 10 mils; heavy linings and coverings, such as the usual rubber linings, $^1/_8$ to $^1/_4$ inch; and coatings. Also coverings of intermediate thicknesses, from 20 mils to $^1/_{16}$ inch, which can be readily obtained by such materials as certain of the liquid-applied bitumin-base materials and certain neoprenes.

Kenneth Tator, Kenneth Tator Associates, Coraopolis, Pa.

For all uses where cleanliness is the objective, where abrasion and impact are of little consequence, and where direct contact with strong corrosives is not encountered, the thin film coatings of vinyls, chlorinated rubber, brushing or spraying neoprenes, and bitumins have been successfully used. Such uses include the coating of the exteriors of all production equipment, pipe lines, and the paper machine, as well as maintenance protection of walls, ceilings, and structures of the production buildings and areas. These materials all have excellent resistance to the corrosive and humid atmospheres encountered in any stage of pulp or papermaking, and are readily applied to a clean, dry surface by spray or brush. All dry at normal atmospheric temperatures. It is usually difficult to maintain dry surfaces for coating application under the humid conditions prevailing in this industry, and it is noticeable that those coating compositions having the greatest latitude in regard to surface preparation, namely chlorinated rubber and the bitumins, give generally better performance.

The baked phenolic coatings have especially earned themselves an accepted place in this industry. The smooth, glass-like finish of these hard, tough bacteriophobic coatings have led to their long successful use in combating slime formation in pulp slurry and white water lines and equipment. They are resistant to all of the corrosive environments, except those encountered in the digester room and cooking liquor cycles of alkaline pulping processes. These coatings require baking at temperatures of 350°F. to complete their application. Therefore field applications are seldom made except for the protection of large or heavy fixed equipment.

Specific listing of equipment on which these thin film coatings have been successfully used resembles a bill of equipment for a pulp mill excepting the digester house, and includes pulp washers and washer drums, pulp measuring devices, rectifier and distributor rolls, beaters, stock chests, stock pumps, flow boxes and baffles, suction box covers, and white water systems.

The heavy linings forming resilient cushions and corrosion barriers, exemplified by rubber applications in thicknesses from $^1/_8$ to $^1/_2$ inch thick, find application wherever severe abrasion or impact or strong corrosives are encountered. They also find many applications where their resiliency is important such as for squeeze rolls. The bleach room applications of these linings are many. Their dependable performance against strong corrosives is further demonstrated in their use as linings for alum mixing tanks. Some of the other successful applications of these linings are for all lines and equipment which the acidic pulp from sulphite digestion contacts from the flow tanks up to and including the pulp washes and fitters, and the sulphite waste liquor handling system.

The third type of organic protectives, namely those most practically applied in thicknesses of 20 mils to $^1/_{16}$ inch have not been sufficiently emphasized by their use in this industry although their suitability has been thoroughly proved in pulp production. They will here be designated as heavy-duty coatings to distinguish them from the thinner protective coatings and the heavier linings and coverings. At the present time these are notably represented by certain bitumen and neoprene compositions. Their utility, like their applied cost, falls between that of the thin coatings and the heavy rubber linings, serving satisfactorily in services too severe for the former and which do not justify the higher cost of the latter. They may be reliably applied by better mill maintenance departments and are also available as applied linings by many lining companies.

The bitumen-base materials, applied by brush, spray, or hot melt depending on composition, are used for maintenance coating of equipment exteriors and heavy-duty maintenance painting. The neoprene-base materials, possessing also the resilience and chemical resistance typical of this vulcanized rubber, find many further applications where an appreciable

degree of abrasion and chemical corrosion resistance is required. This lining has been successfully used in all applications previously mentioned for the thinner coatings and in addition has given excellent service as alum mixing tank lining.

Part II—Bleaching

High-Silicon Irons

Walter A. Luce

High-silicon iron alloys show excellent resistance to chlorine and chlorine compounds and are, therefore, widely used in the pulp and paper industry for handling bleach solutions. Chlorine compounds, including sodium and calcium hypochlorite, moist chlorine gas, and hypochlorous acid, are normally very corrosive; the high-silicon iron alloys are among the few materials of construction having the high degree of corrosion resistance necessary for successful handling of these compounds.

Duriron is a high-silicon iron alloy with a nominal chemical composition of 14.5% Si, 0.75 Mn, and 0.90 carbon. Durichlor contains an additional 3% Mo; this gives increased resistance to hydrochloric acid and many chlorine compounds. Both alloys are supplied in the cast form only. Because of their extreme hardness, any machining must be done by grinding methods. Nevertheless, these alloys are available in many forms of chemical equipment such as pumps, valves, ejectors, pipe, tank outlets, jets, fans, and spray nozzles, which makes them applicable to bleach make-up and handling.

Since Durichlor is the better alloy for handling chlorine and most chlorine compounds, it is usually the preferred analysis for bleach handling. This is especially necessary for the conditions where chlorine gas is encountered in the presence of moisture; Durichlor is generally recommended for use at the point of chlorine introduction into the system. For instance, Durichlor is used in numerous installations where bleach make-up is done by merely introducing chlorine at the bottom of the tank and allowing it to be absorbed as it is bubbled through the milk of lime or sodium hydroxide.

Durichlor is even more widely used where the bleach make-up liquor is recirculated by a high-silicon iron pump and the chlorine is continuously introduced by a Durichlor ejector. This procedure results in more adequate mixing of the chlorine and thus provides more complete absorption. This recirculating pump can also be used to transfer the bleach to the point of use. Supersaturated chlorine water solutions are also produced by this method. These solutions have been reported as ranging in concentration from 57.5 pounds of chlorine per 1000 gallons of water to as high as 100 g.p.l. of chlorine. Under these varied conditions, the service life of Durichlor ejectors ranges from 6 months to $2^1/_2$ years. Corrosion is especially severe in the ejector because of the combination of chemical attack and high velocity. This severe combination usually results in early failure of alloys not exhibiting the required high corrosion resistance. One paper company is also using Durichlor inlet pipe for introducing chlorine directly into the bleacher. This installation is still providing successful service after five years' continuous operation.

Although Durichlor shows good resistance to nearly all chlorine conditions, there are many services for which Duriron has adequate resistance. It, too, is extensively used in bleach handling and provides ideal service for bleach transfer lines because of its immunity to corrosion. Transfer pumps and valves are also commonly used in such installations. In contrast to cast iron or steel pipe in calcium hypochlorite service, there is no scale build-up in Duriron pipe to cause clogging of the lines and perhaps contaminate the finished paper. In sodium hypochlorite handling Duriron lines, valves, and pumps provide a service life in terms of years in comparison to a few months at the most with cast iron or steel.

High-silicon iron pumps are not normally used for handling chlorinated chemical wood pulp stock because they are not designed to handle the required high capacity or the high percentage of suspended matter. However, on several occasions Durriron has been successfully applied as a pump material where the stock consistency did not exceed $3^1/_2$%. No corrosion was evident after many years' continuous handling of this corrosive material.

In addition to the standard bleach solutions, experience indicates that the high-silicon iron alloys should be considered for handling other bleach solutions such as chlorine dioxide and sodium chlorite. Test information compiled to date indicates that these alloys show very little corrosion under service conditions.

Walter A. Luce, The Duriron Co., Dayton, Ohio.

Cements

Raymond B. Seymour

Corrosion-resistant cements are less resistant to bleaching processes than to any other phase of the pulp and paper industry. Portland cement has been considered acceptable in some alkaline bleach processes even though it is fairly rapidly attacked. Obviously, Portland cement is unsatisfactory for acid bleach. Silicate cements cannot be used for alkaline bleach solutions but give fair results on the acid side. Litharge-glycerol and sulphur cements are usually considered unsatisfactory. Phenolic or furfuryl alcohol cements are generally selected as the most effective materials.

Corrosion of Resin Cements Immersed in 5% Sodium Hypochlorite at Room Temperature

Cement	*Per cent loss in weight*		
	10 days	*20 days*	*30 days*
Carbon-filled polyfurfuryl Alcohol	3.7	4.3	7.5
Quartz-filled phenolic	8.1	...	10.9
Carbon-filled phenolic	1.9	1.6	1.6

Furfuryl alcohol cements are preferred for alkaline solutions and phenolic cements for acid bleach but both require occasional repainting. An alkaline-resistant phenolic resin appears to be the most satisfactory cement for chlorine oxide bleaching. A recently developed hot melt cement based on a hydrocarbon synthetic resin has shown promise in several installations but not enough performance data are available to date to warrant any definite recommendations.

Data in the above table show the per cent loss in weight with time for various cements immersed in 5% sodium hypochlorite at room temperature.

Raymond B. Seymour, The Atlas Mineral Products Co., Mertztown, Pa.

Nickel, Nickel Alloys

H. O. Teeple

The bleaching of paper stocks has assumed considerable importance during the last several years. Consequently, serious corrosion problems have confronted the industry in this phase of papermaking.

Various bleaching agents have been used, such as chlorine, chlorine dioxide, sodium chlorite, sodium or calcium hypo-

H. O. Teeple, International Nickel Co., New York, N. Y.

chlorite, sodium peroxide, zinc hydrosulphite, and possibly others.

Of these various bleaches the ones containing active chlorine are responsible for the more aggressive corrosion problems. This is due primarily to the fact that the number of materials of construction useful for handling wet chlorine or strong hypochlorite solutions is quite limited.

When chlorine is used as the active bleaching agent, a multistage system is used to obtain a controllable degree of stock brightness. The number of stages can be from one to as many as eight. The number of stages required is based upon the extent of bleaching desired for a given stock. A four-stage system consists of a low consistency direct chlorination, a caustic extraction, a high density hypochlorite treatment, another caustic extraction followed by a second hypochlorite bleach and subsequent washing.

Generally tile-lined chests are used to resist corrosive attack by the bleaches as well as to minimize color contamination of the stock. In direct chlorination rubber-covered agitators have been used rather successfully. As far as metallic materials are concerned, a nickel-base alloy containing high percentages of chromium and molybdenum is practically the only alloy commercially available having adequate resistance to corrosion by wet chlorine. Monel and nickel, Inconel, and Ni-Resist are not generally suitable for this severe service.

However, Monel is suitable for use as covers on the caustic extraction washers and on the hypochlorite thickeners, service life performance indicating 1 to 3 years' performance.

A plant corrosion test in filtrate from a washer handling hypochlorite bleached soda pulp illustrated the suitability of Monel. Results are shown in Table I.

Table I. Corrosion by Filtrate from Washer Handling Hypochlorite-Bleached Soda Pulp

Chlorinte Content 0.009 G./L., pH 6.0 Temp. 23°C., duration of Test 72 Days, Filtrate Flow 1050 G.P.M.

Material	*In./yr.*
Monel	0.0001
Nickel	0.0001
Inconel	0.0001
Ni-Resist	0.002

Monel is not suitable for handling chlorine bleached stock and this point is illustrated by the data in Table II.

Table II. Corrosion by Chlorine-Bleached Stock

Paper Stock Containing 0.15 G./L. HCl and 0.02 G./L. Free Chlorine. Duration of Test 90 Days

Material	*In./yr.*
Monel	0.043
Ni-Mo-Cr alloy	<0.0001
Ni-Resist	0.023
Type 316 stainless	0.0001

As these data indicate, the molybdenum bearing austenitic stainless steel is suitable for this application; plant service experience has verified this point.

It should be noted in passing that rubber-covered steel parts for washers and thickeners have received widespread acceptance as a means of prolonging service life of such equipment.

The use of sodium peroxide as a bleaching agent has generally been confined to the bleaching of groundwood. The use of this alkaline bleaching agent does not result in many severe corrosion problems. Monel, nickel, Inconel, and Ni-Resist are all suitably resistant to corrosion by these bleach solutions. The use of these materials provides adequate service life and in addition preserves the quality of bleached pulp by preventing color contamination. Carbon steel and cast iron would be expected to show reasonably low rates of corrosion but experience has indicated their use is not conducive to the maintenance of a bright stock.

Zinc hydrosulphite is also used for the bleaching of groundwood pulp. This bleaching agent is relatively new but corrosion tests have indicated that the use of Monel is suitable for handling the bleached stock. Tables III and IV show this to be true.

Table III. Corrosion in a Stock Chest Handling Zinc Hydrosulphite Bleached Stock

Temp. 74°F., pH 4.5, Duration of Test 209 Days

Material	*In./yr.*
Monel	0.002
Nickel	0.003
Inconel	0.0001
Ni-Resist	0.003

Table IV. Corrosion in Inlet to Bleached Stock Washer

Temp. 139°F., pH 4.2, Duration of Test 209 Days

Material	*In./yr.*
Monel	0.001
Nickel	0.004
Inconel	0.0001
Ni-Resist	0.003

In conclusion, corrosion problems arising in the bleach house tend to be serious. But judicious use of available materials of construction generally will mitigate the severity of the problems so that an economic operation will result.

Chlorimet

Walter A. Luce

Chlorimet 3 shows excellent resistance to chlorine and chlorine compounds and, therefore, finds application for handling bleach solutions in the pulp and paper industry providing the temperature remains low. This alloy is resistant to moist chlorine gas and all hypochlorite bleach. concentrations commonly encountered in pulp bleaching; it can be successfully applied to both bleach make-up and handling.

Chlorimet 3 is a nickel-base alloy with a nominal chemical composition of 60% Ni, 18 Mo, 18 Cr, 3 Fe max., and 0.07 C max. The nickel-molybdenum alloy Chlorimet 2, which has a nominal chemical composition of 63% Ni, 32 Mo, 3 Fe max., and 0.10 C, is severely attacked by chlorine in the presence of moisture and by unstable compounds. It is not recommended for use in bleaching operations because of their oxidizing capacity. Both alloys are available in the cast form only.

Despite the excellent resistance of Chlorimet 3 to commercial pulp bleaching conditions, it is only applied in specific services where less expensive alloys will not suffice. In addition to the comparatively high initial cost of this type alloy, the fact that it is only available in the form of pumps and valves has also restricted its use since the high-silicon iron alloys, Duriron and Durichlor, also show equivalent corrosion resistance and are much lower in cost. Its greatest application to date has been in plug valves in combination with Durichlor for handling moist chlorine gas and bleach solutions containing a high available chlorine content. The high strength of the Chlorimet 3 valve body and the high hardness of the Durichlor plug make an ideal combination for services where galling resistance and excellent corrosion resistance are desired. Chlorimet 3 pumps are also being successfully used in handling hypochlorite bleach solutions where a high strength alloy is desired.

Walter A. Luce, The Duriron Co., Dayton, Ohio.

Durimet 20

Walter A. Luce

Durimet 20 shows satisfactory resistance to many of the common bleach solutions used in the pulp and paper industry. For instance, experience indicates that it is capable of handling the alkaline bleach solutions, sodium, and calcium hypochlorite, at ambient temperatures if the concentration does not exceed approximately 3% available chlorine. However, it is necessary, as with all stainless steel in the presence of chlorine or unstable chlorine compounds, to be extremely cautious in its application since these corrosives can cause severe and often unpredictable attack.

Despite the indicated good service from this alloy in pulp bleaching applications, it is not widely applied in the pulp and paper industry. Equipment made from castings, such as pumps and valves, can be purchased in the high-silicon iron alloys, Duriron and Durichlor, and the nickel-molybdenum-chromium alloy, Chlorimet 3, without restriction to the concentration being handled. This fact suggests the primary reason that the use of Durimet 20 is not more widespread. In addition, it appears that it is not greatly superior to the conventional molybdenum 18–8-S stainless steel for bleach handling of the recommended concentrations. To date it has been used primarily for agitators, bleach inlets, and to a limited extent, for pumping.

Durimet 20 is a highly alloyed stainless steel with a nominal chemical composition in the cast form of 29% Ni, 20 Cr, 2 Mo, 3.5 Cu, 1 Si, 0.07 C max., and balance Fe.

Tantalum

Leonard R. Scribner

At the temperatures at which they are used as bleaching agents in the paper industry, neither chlorine, sulphur dioxide, hydrogen peroxide, nor chlorine dioxide attacks tantalum; and tantalum can be used in the presence of these materials, either wet or dry, with complete safety as far as corrosion is concerned.

Because bleaching is usually done at low temperatures and concentrations, conditions are seldom severe enough to require the use of tantalum equipment.

Iron and Steel

Arthur E. May and Albert W. Spitz

Unprotected cast iron and carbon steel are of limited use in the bleach plant of a modern pulp mill. With suitable coating or lining, however, these materials are used extensively.

A typical plant will consist of a brown stock chest, two or more washers, a chlorinator, hypochlorite cells, pumps, piping, and miscellaneous auxiliaries. The applications of cast iron and carbon steel are as follows:

Brown stock chests may be constructed entirely of iron or steel, including agitation equipment. Tile chests with cast-iron agitators are commonly used.

Iron and steel are not recommended for chlorinator construction.

First-stage washers are frequently built of cast-iron and carbon steel, all parts in contact with the product being rubber covered.

Hypochlorite towers are usually tile. Rubber-covered iron and steel agitators and baffles are satisfactory.

Bleach plant pumps are usually built of more corrosion-resistant materials.

Piping of lined steel is in general use. Cast iron may be used for bleach liquor lines.

Worthite

W. E. Pratt

Bleaching in the pulp and paper industry is usually accomplished with chlorine and chlorine compounds. Chrome and chrome-nickel stainless steels are of little use in these environments. The high nickel-chrome-moly alloys are more resistant and some of them have proved economical in the alkaline bleaching—calcium and sodium hypochlorites.

Worthite (Ni 24, Cr 20, Mo 3, Si 3.25, Cu 1.75) is one of these alloys that has attained a definite economical position for handling cold hypochlorite bleaching solutions as generally used in the pulp and paper industry as well as in the textile industry. To a lesser extent it is used in other industries such as oil refining. Based on long experience, the upper limits of concentration for satisfactory service from Worthite pumps has been set at $3^1/_2$% available chlorine for calcium hypochlorite, and 3% available chlorine for sodium hypochlorite. These recommendations apply up to 90°F. although in a few instances good results have been reported up to 120°F. In one case it was reported that Worthite was satisfactory handling NaOCl with 5% available chlorine, but it is not recommended for that concentration.

In a calcium hypochlorite bleach make up system (3% available chlorine) installed at the American Writing Paper Corp., Holyoke, Mass., a 2CG-1A Worthite pump circulates and mixes milk of lime and chlorine, and delivers bleach to beaters. No repairs have been required on this pump which was installed in 1945.

In one plant Worthite pumps are used for $CaOCl_2$ with up to 23% available chlorine. Repairs are required rather frequently, but the user claims the low cost and quick availability of parts makes their use more economical than the higher cost, more corrosion-resistant alloys.

In making tests on Worthite specimens in the alkaline hypochlorite solutions to establish whether a pump would be suitable, it is recommended that the test duplicate as far as possible the exact conditions under which the pump would be used. Thus a test on a specimen that is suspended at a point where strong light hits it and where the specimen is not continuously submerged does not duplicate the conditions inside the pump. In fact, such a test has indicated a tendency to pit whereas a Worthite pump has given many years of service.

Also, in making a corrosion test, if other metals or alloys are included in the system, the corrosion test should be so made as to determine if there will be any damaging galvanic action to one or the other of the alloys. If there is any such indication then it may be wise to insulate the pump from the system by using rubber acid hose on the suction and discharge, and rubber hose for the independent water seal line to the stuffing box. It is rarely necessary to go to absolutely complete insulation of the pump as is done in electrolytic plants to avoid stray electric current corrosion.

In multistage bleaching, where chlorine gas or chlorine water is used in the first stage, there is usually present both hypochlorous acid and hydrochloric acid resulting in low pH solutions. Worthite is not recommended for this stage.

For corrosive bleached stock pumps, a Worthite pump would have to be made up special and the usual pattern equipment for such pumps is not suitable. Hence, it is rarely economical to consider Worthite for stock pumps. The large volume of Worthite pumps used for hypochlorite bleach solutions is therefore in standard chemical pumps which are available from stock at reasonable prices. Many of these pumps have been in service for 10 to 12 years.

Walter A. Luce, The Duriron Co., Dayton, Ohio.

Leonard R. Scribner, Fansteel Metallurgical Corp., North Chicago, Ill.

Arthur E. May, Moore and White Co., Philadelphia, Pa., and Albert W. Spitz, Reiter Engineering Co., Philadelphia, Pa.

W. E. Pratt, Worthington Pump and Machinery Corp., Harrison, N. J.

For peroxide bleaching Worthite is suitable for all known conditions. While this method of bleaching is employed principally in the textile industry, it is of interest to report that Worthite pumps are widely used for tank car unloading and transfer pumps. The best known and most widely used system has standardized on Worthite pumps.

Coatings

Kenneth Tator

Bleaching operations in the pump and paper industry are usually carried out by treatment of the pulp by chlorine followed by caustic soda. This treatment may be replaced or followed by treatment with sodium or calcium hypochlorite. These processes are carried out at temperatures below 160°F., well within the thermal limitations of the usual organic protectives. Exposure conditions are therefore highly oxidizing at all stages, acidic in case of direct chlorination and alkaline in the caustic or hypochlorite stages, with high concentrations of chloride ions throughout all operations.

The selection of suitable organics then narrows to those materials which are resistant to oxidation, ideally but not necessarily resistant to both high and low pH, and for the acid stage, impermeable to hydrogen chloride permeation. The materials meeting these specifications include high-molecular-weight vinyl copolymers, polyethylene, tetrafluorpolyethylene (Teflon), vinylidene chloride polymers (Saran), and hard rubber. To obtain best resistance against HCl premeation the vinyls and vinylidene chlorides should be effectively stabilized. Application techniques for polyethylene and Teflon are now in the process of being perfected, hence past successful use has been limited to hard rubber, and more recently have included the vinyls and Saran. The resistance of natural rubber is fortified by an impermeable rubber hydrochloride film built up on its surface by the action of hydrogen chloride. One mill reports a use to date of 14 years with rubber-lined pumps and piping in pulp bleaching service. Rubber is also in use for chlorine mixers, as coverings for bleach tower agitators, and for covering of bleach wash tanks and filters.

The problem of general industrial maintenance in bleach houses is intensified by the constantly prevalent humid, chlorine-permeated atmosphere. For protection of exteriors of equipment and structurals, and for general maintenance painting the protective coatings which display good resistance to this atmosphere and which may be successfully applied under humid conditions have proved satisfactory. These include chlorinated rubber, bitumin, and vinyl coatings. The latter, for most successful application should be of a suitable wash prime system.

Lead

Kempton H. Roll

The bleaching of wood pulp (groundwood, sulphite, soda, or sulphate) has for its object the production of a whiter and brighter stock. It improves the natural color of the pulp and also brightens pulps containing metallic compounds such as iron tannates. In addition, bleaching may also involve the purification of cellulose fiber by chemically removing ligneous material as well as other residues in the pulp.

Groundwood is generally bleached by applying dilute solutions of calcium or sodium bisulphite to the pulp, or by adding small quantities of zinc hydrosulphite either continuously by means of a dry feeder or batchwise or as an aqueous suspension from a closed mixing tank.

Sulphite and soda pulps have for many years been bleached almost exclusively with a solution of calcium hypochlorite. This was prepared by mixing bleaching powder with water and drawing off the clear, supernatant liquid. Within recent years this practice has given way to the use of liquid chlorine and milk-of-lime. Recent advances in the technique of bleaching make use of direct chlorination of the pulp along with hypochlorite and other chemical treatment.

The equipment now in use for carrying out the bleaching operation varies considerably. In the bleaching of all chemical pulp, lead is used to handle chlorine gas under approximately atmospheric conditions of temperature and pressure, particularly in the bleach liquor make-up tanks where a perforated lead coil in the bottom of the tank is used to get gas distribution.

Lead is recommended as a material for handling moist chlorine up to 230°F.

A continuous pulp bleaching operation using sulphurous acid in two antimonial lead-lined tanks has been put into use in a West Coast mill. One tank is used for 24 hours and then cut out while the other is used for the next 24 hours. Antimonial lead valves and pipe serve to convey the bleaching solution, a water solution of sulphur dioxide at room temperature.

First developed to procure a brighter paper from western groundwood, zinc hydrosulphite is now a standard bleach for newsprint, specialty papers, cheap magazine and catalog papers, and various boards. In kraft manufacture it is used as a brightening agent but not as a substitute for the complete bleaching process.

Chemically, zinc hydrosulphite is ZnS_2O_4; a white, anhydrous powder. A saturated solution contains 17% hydrosulphite. It has a powerful bleaching action, far exceeding that of sulphur dioxide or bisulphites. Bleaching action at ordinary temperatures is usually completed in less than 5 minutes. It is nonpoisonous and only slightly corrosive on the skin but does attack most metals with the exception of lead.

Zinc hydrosulphite is manufactured from liquid sulphur dioxide and zinc dust in lead-lined tanks using cooling coils made of lead. Bleaching operations employing liquid zinc hydrosulphite use lead pipe lines for conveying the chemical to the point of use.

While the bleaching of groundwood by the zinc hydrosulphite method is not widespread, lead is excellent for handling the stock after the zinc has been added. In one process now in use, the zinc hydrosulphite powder is added to the pulp at a predetermined rate, passed through a pump to get thorough mixing, delivered to a chest or tank, and allowed to stand until bleaching is completed. Because the pulp and zinc hydrosulphite mixture is acid (pH 4.5) from the presence of sulphur dioxide and other sulphur compounds, the use of lead is definitely warranted. Lead also has the important advantage at this point of not discoloring the pulp.

Recently hydrogen peroxide has been used for bleaching certain wood pulps. Lead can be used to handle this chemical at practically all normal bleaching concentrations with little or no corrosion.

Rubber

James P. McNamee

In the production of fine varieties of light-colored paper, bleaching of the pulp is a necessary and very important step. Bleaching is essentially an oxidizing reaction and the most common chemical agents used to carry out the process are liquid chlorine and chlorine-bearing compounds. Since

Kempton H. Roll, Lead Industries Association, New York, N. Y.
Kenneth Tator, Kenneth Tator Associates, Coraopolis, Pa.
James P. McNamee U. S. Rubber Co., Providence, R. I.

rubber compositions exhibit excellent resistance to these oxidizing agents, rubber-lined steel is an ideal material of construction for bleach plant equipment.

Hard natural rubber is extensively used for handling both dry and wet gaseous chlorine and chlorine water up to the saturation point. The dry gas has very little effect upon hard rubber, but the wet gas reacts with the surface to form a layer of rubber chloride. It develops quickly when the chlorine first contacts the rubber surface; once formed, it acts as a protective film and prevents further penetration and reaction with the rubber. The character of this reacted surface and the depth to which the reaction occurs can be controlled by specific compounding and vulcanization of the rubber lining. None of the available types of synthetic rubbers appear to have any advantages over natural rubber for this service.

An operating temperature of 180°F. is usually set as the safe maximum for hard rubber although special compositions are available which may be safely used as high as 220°F.

Hard rubber linings should be considered for process and storage tanks, pipe, fittings, valves, pumps, agitators fans, and duct-work. A $^3/_{16}$-inch thickness of lining is usually recommended, although for extreme service conditions of $^1/_4$-inch thickness will more than pay for itself in additional service life. Since linings are tailor-made for each installation, the rubber manufacturer should be supplied with all possible information on the exact service under which the lined equipment will operate so that the best type and thickness of lining can be furnished. There is no limit on the size of equipment which can be lined with rubber. Large chlorination towers 15 feet in diameter and 60 feet high, used in continuous bleaching systems, are regularly constructed of rubber-lined steel. Continuous rotary vacuum washers for washing chlorinated pulp usually consist of a hard rubber lined vat and a hard rubber-covered drum. The drum also contains hard rubber ribs which act as supports for the wire screen.

Although it is less expensive to have lining work done at the rubber factory, for equipment too large to transport or equipment that must be fabricated in place, the lining can be applied by field crews who have had extensive experience in this type of work.

In order to provide the maximum resistance to physical and thermal shock and to provide years of trouble-free operation, a hard rubber lining should contain a softer layer of rubber next to the metal. This forms a cushion between the hard, chlorine resistant outer layer and the metal surface. A construction of this type will eliminate the danger of a lining cracking during normal service.

In the majority of bleaching applications in the paper industry, abrasion is not a factor, and hard natural rubber is the best type of lining to use. If considerable abrasion is present, however, soft natural rubber should be considered. The reason for this is based on the difference in the film which forms on soft rubber as compared to the film which forms on hard rubber. Soft rubber compositions react more readily with chlorine and tend to form a thick skin which is brittle but quite strongly adhered to the unreacted rubber underneath. Hard rubbers react much more slowly and to a lesser depth than the soft rubbers; however, the chlorinated surface tends to powder off more readily. In services involving abrasion, these hard linings are sometimes subject to more rapid disintegration than soft rubber for the reason that the reacted surface is readily abraded away thus exposing more unreacted rubber which in turn chlorinates and powders off. Soft rubber is preferred in such cases, despite its greater susceptibility to chlorination because the reacted surface is firmly anchored to its parent material.

Sodium hypochlorite and calcium hypochlorite solutions are also satisfactorily handled in rubber-lined equipment. This is particularly true of the tanks in which the solutions are mixed and stored. Both soft and hard compositions have been used for this purpose, although soft natural rubber of the pure-gum type appears to be less attacked by these chemicals. Many lining materials have a tendency to accelerate the decomposition of hypochlorite solutions and are, therefore, unsuitable for storage equipment. Special soft natural rubber linings are available which are unattacked by these bleach solutions, do not decompose or contaminate them and will not blister away from the metal wall—a difficulty which is quite common with ordinary soft rubber linings. This type of lining has also been used successfully in sodium peroxide bleaching operations.

Solid plastic pipe of the Uscolite type is resistant to gaseous chlorine, chlorine water, and calcium and sodium hypochlorite solutions.

Part III Acid Pulping

Worthite

W. E. Pratt

In the acid pulping processes the digester liquor is usually calcium bisulphite. Sulphur is burned to sulphur dioxide, the gas is cooled and absorbed in water to make sulphurous acid, which in turn contacts limestone to form the raw calcium bisulphite cooking liquor. This reaction is commonly carried out in Jenssen towers packed with limestone, the SO_2 gas passing upward countercurrent to the water or acid flowing downward. Water is introduced into the top of the first tower and a pump delivers the weak acid to the top of the second tower.

Another tower pump takes the strong acid from the bottom of the second tower and delivers it to the settling tank, storage, or to the reclaim tank. The reclaim or accumulator tank is so called because the digester relief gas is piped into this tank for absorption into the liquor.

Usual practice for an acid tower installation is to provide three towers with only two in use while the third tower is being repacked with limestone. Occasionally four towers are used. The older milk of lime systems–employ a series of tanks as a cascade or a tower partitioned off into sections. Cooking acid made in this system requires settling before passing to storage or to the accumulator. It will be seen that in either system two to four acid pumps may be required. Worthite pumps are very frequently used for these services. They seem to be practically corrosion-proof as Worthite pumps in these services for 13 years show no attack. This is a great improvement over the bronze pumps formerly used before the advent of the chrome-nickel and nickel-chrome-moly alloys.

Prior to passing the sulphur dioxide gas over the acid towers, the gas must be cooled to as low a temperature as practical as the absorption is greater at the lower temperatures. Gas cooling is frequently accomplished by drawing it through cooling towers over which water is pumped. As the water picks up a little of the SO_2 at this point acid pumps are required. This is another place where Worthite pumps are used frequently. The cooling water enters the tower through a distributor pipe which it has been found economical to make of centrifugal cast Worthite pipe with suitable drilled holes.

In the digester room additional pumps are required for filling the digester with cooking acid, boosting the acid into the digester after it is under partial or full pressure, and in many mills the cooking acid is recirculated around the digester through indirect heaters. Standard Worthite pumps are available for all of these services, except for some recirculating systems where special pumps are required built to order. In such cases the 18–8S, molybdenum, or type 316 stainless

W. E. Pratt, Worthington Pump and Machinery Corp., Harrison, N. J.

steels may be used due to the lower cost. Where standard Worthite pumps will meet the hydraulic requirements the Worthite pumps will be lower in cost due to volume production.

Worthite may have some additional advantage over the moly-bearing stainless steel where some sulphuric acid is present. Sulphuric acid may be formed on wetted surfaces during shutdown periods. Also some SO_3 is likely to be present at times during periods when the system is a little out of balance, or in the milk of lime systems. This SO_3 must be scrubbed out as completely as possible and it is done usually in lead towers over which a hot, weak mixture of H_2SO_3-H_2SO_4 is circulated. This solution is reducing in nature and tends to activate the nickel-chrome-moly alloys. Concurrently, the lead in the towers and pipes takes on a heavy coating of lead sulphate which may be cathodic to an alloy pump or valve, causing galvanic action damaging to the alloy. Worthite is very resistant to the corrosive action of the solution but a Worthite pump should be completely insulated from any metallic contact with the lead in such systems. The Worthite pumps handling the H_2SO_3 alone, or the cooking acid, remain in the passive state and hence are cathodic (passive) to lead and are therefore galvanically protected by contact with the lead.

The relatively new acid pulping liquor, employing magnesium or ammonia-base sulphite liquor, presents similar corrosive problems. Since these liquors may be recovered in a similar manner to the sulphate (alkaline) liquor employed in kraft pulp mills, by concentrating the weak wash liquor and burning in a recovery boiler, many more chemical pumps are required in the recovery processes. Worthite pumps are used in the few plants employing these newer digester liquors and they are giving an excellent performance.

Some of the sulphite mills have taken steps to avoid stream pollution and have installed various processes to utilize the chemical values in the waste liquors. Worthite is suitable for all of the corrosion problems involved in such plants. One of the sulphite-pulp mill by-product plants manufacturers vanillin and Worthite pumps are used in this plant.

The following corrosion tests on Worthite in sulphite liquors were reported by the International Nickel Co.:

"Spool installed for 54.5 days in 4-inch pipe just below the upper cone of No. 4 tank for digestion of wood chips with sulphite paper digester liquor (average initial composition 8.23% total SO_2, 7.02 free SO_2, 1.21 combined SO_2, cooking acid 7.42 total SO_2, pH 1.32). No aeration, slight agitation, temperature 267°F. (65–70 p.s.i.g.). Worthite corrosion rate 0.00008 inch per year, no pitting.

"Spool installed 28 days in cover of a sulphite digester (cooking liquor: total SO_2 7.87%, free 6.82, combined 1.05) for manufacture of newsprint. No aeration, some agitation, temperature 291°F. Worthite corrosion rate 0.00013 inch per year no pitting.

"Spool was installed for 51 days attached to the digester strainer used in sulphite pulp cooking. Liquor contained 7.5% total SO_2; 1.2 was combined, 6.3 free. Temperature 86 to 293°F. No aeration or agitation given. Worthite corrosion rate 0.001 inch per year, no pitting."

Lead

Kempton H. Roll

Acid pulping is the process of digesting cellulosic materials such as barked and cleaned wood by cooking it in sulphite liquor. The product of acid pulping is essentially pure cellulose pulp, the unwanted and unstable lignin and other noncellulosic components of the wood having been dissolved away by the treatment.

Kempton H. Roll, Lead Industries Association, New York, N. Y.

"Acid" in acid pulping refers to the sulphite cooking liquor which consists of the acid sulphites or bisulphites of calcium and occasionally magnesium in solution with sulphur dioxide.

The manufacture of the sulphite cooking liquor, an operation invariably conducted on the premises of each individual pulp mill, begins with the burning of sulphur in conventional burners to form sulphur dioxide. While it is theoretically possible to secure a gas of nearly 20% concentration, practice has shown this to be impossible because the excess air input together with small amounts of moisture in both the sulphur and the air combine to favor the formation of sulphuric acid. Temperature also plays a part in the conversion of sulphur dioxide to trioxide; hence the necessity for cooling the gas as rapidly as possible through the critical temperature range. As long as the gas temperature is above the boiling point of sulphuric acid (about 600°F.) iron piping is satisfactory. But when the temperature is sufficiently reduced sulphuric acid mist forms and corrosion proceeds at a rate making most construction materials impractical with the exception of lead and its alloys, antimonial lead, and tellurium lead.

Normally the temperature of the combustion chamber is 2000°F. or above. The sulphur dioxide gas enters the distributing header over the cooler at about 1400°F., depending upon the length of piping between the combustion chamber and cooler and the ambient temperature. In order to permit proper absorption of the gas in the acid-making towers it must first be cooled to 90 to 150°F.

It is in this cooling step that lead, because of its resistance to sulphuric acid, plays such an important part. The gas is distributed to a number of lead pipes usually 8 inches in diameter with $^1/_4$-inch wall and about 15 feet long, submerged in a pond of cooling water. These, in turn, discharge into a submerged lead header to which are connected a multiplicity of vertical elliptical lead pipes, 3 by 8 inches, $^1/_4$-inch wall and about 15 feet high. The elliptical lead pipes are individually connected at the top by a short section of lead pipe to a second set of vertical elliptical piping leading to a second submerged header, thence to a third set of similar piping, and finally to a fourth set which is connected to a header leading to a gas fan.

All the cooling water before entering the pond is distributed at the top of the vertical piping so that a film covers the entire surface. Thus the gas gets a preliminary cooling in the submerged lead pipes and final cooling in the four passes into vertical elliptical pipe. The sulphuric acid condensed in the cooler is trapped out from each of the submerged headers but is not completely removed from the gas. Of recent years tellurium lead as well as antimonial lead has been used for cooler piping.

From the coolers the gas enters a large fan which pulls the gas through the sulphur burner combustion chamber and gas cooler and then forces it up through the acid or absorption towers. The fan bowl is cast antimonial lead split horizontally to permit cleaning; the impeller either cast lead or lead-covered steel; and the shaft lead-covered steel. From the fan the cooled gas is discharged through a four-way lead plug cock and passed into a series of two or more acid towers more than 100 feet high filled with broken limestone. Large lead ducts, 2 to 4 feet in diameter, assembled in the field, are used to conduct the gas from the top of one tower into the base of the other, again through a four-way lead plug cock.

Acid sulphite is generated in the tower as sulphur dioxide reacts with the limestone in the presence of a fine spray of water passing downward through the system countercurrent to the gas. Calcium bisulphite liquor is produced containing an excess of free sulphur dioxide. In the parlance of the pulp manufacturer, the "free" sulphur dioxide is the sum of that as sulphurous acid and that portion which requires alkali to convert from an acid sulphite to a neutral sulphite.

Waste carbon dioxide, moisture, and traces of sulphur dioxide are discharged through a valve to the atmosphere.

Cement	Resistance to Ca bisulphite	Resistance to sol. sulphite	Effectiveness at temp. above 200°F.	Absorption, %	Adhesive strength	Coeff. of Expansion $\times 10^{-1}$
Furfuryl alcohol	Excellent	Excellent	Excellent	<0.5	Excellent	6
Phenolic	Excellent	Excellent	Excellent	<0.75	Very good	7
Sulphur	Excellent	Excellent	Poor	<0.5	Good	8
Silicate	Fair	Poor	Excellent	10	Very good	6
Litharge-glycerol	Good	Poor	Good	5	Very good	9
Portland	Poor	Poor	Good	5	Good	6

Water with acid and finished raw acid are redistributed to the towers by a six-way lead plug cock. The water and acid lines to and from the towers are lead. To permit recharging the towers with limestone, the flow of gas and water is alternated each day by manipulating the gas and acid plug valves.

Raw acid is delivered from the acid plant through lead piping to the reclaiming tank. In this tank the raw acid is fortified by cool, strong gas relieved from the digesters. From here the acid flows into storage tanks through lead piping. Storage acid temperature is normally about 90°F. and the pressure close to atmospheric. Since a small amount of sulphuric acid is formed during the cooking process and all is not absorbed in the reclaiming system, lead is by far the best material to handle the excess gas from the tanks. Where reclaiming towers are used, they are generally constructed of chemical tile in a steel shell lined with 8 or 10-pound sheet lead to protect the steel against attack by seeping corrosives. In the majority of plants, wooden acid storage tanks are used. It is common practice to cover the iron hoops on wooden acid tanks with relatively thin-walled lead piping and the turnbuckles with 4-pound sheet lead to prevent their corrosion by acid seepage.

In the cooking process the acid sulphite and wood chips are brought together in a digester lined with acid-resistant brick set in cement composed of litharge (PbO), sand, and glycerine. Temperatures vary from 250 to 350°F. and pressures range from 75 to 125 p.s.i. Here again a lead lining between the brick and shell of the digester is often used as an impervious corrosionproof lining to protect the steel. The combination of brick and lead is being used successfully in other chemical operations up to 900°F. On the top of the digester 1-inch thick antimonial lead covers 36 inches in diameter are giving good service. In some instances, dished steel covers are used lined with 16 to 20-pound lead. Lead digester relief valves, usually 2 to 4 inches, are also being used successfully on digester covers. McKay and Worthington quote a virtually zero corrosion rate for lead exposed in four different sulphite digesters where the temperatures ran anywhere from 275 to 295°F. The solution carried 3.6 to 4.4% free sulphur dioxide and the pressure ran 125 to 146 p.s.i.

Two methods of cooking, direct and indirect, are widely used. In the direct method, the digester is heated directly with steam. The indirect process, on the other hand, utilizes vertical or horizontal digesters equipped with hard lead steam coils. The cooking time is about 58 hours and the maximum temperature and pressure are 266°F. and 60 p.s.i. A newer innovation, lead-covered copper coils, makes operation at much higher temperatures practical.

The maximum safe working steam pressure for antimonial lead coil (6% Sb) is 38 p.s.i. steam gage pressure (284°F.) and for chemical lead it is 55 p.s.i. (302°F.) but lead-covered copper coil may be safely operated up to 150 p.s.i.

Cements

Raymond B. Seymour

Acid pulping brings about the major corrosion problem in the pulp and paper industry but fortunately, these can usually be solved through the use of modern corrosion-resistants cements. Some plants still use lead-lined equipment for digesters but such are being rapidly replaced with more modern design, primarily because of the high coefficient of expansion and creeping of lead.

Modern design usually consists of ceramic linings joined with acidproof cement. Litharge-glycerine cements were formerly standard for joining acid brick in sulphite digesters, acid accumulators, and blow pits. However, since the effectiveness of this type of cement was dependent upon the formation of insoluble calcium salts, its utility was limited to the calcium bisulphite process. Soluble acid pulp processes require phenolic or furfuryl alcohol type cements. Sulphur cements are also resistant to sulphurous acid liquors but are satisfactory only at temperatures below 200°F.

A typical sulphite plant consists of an absorption tower, such as a Jenssen tower, a reclaiming tower, an acid storage tank, and a digester. The acid storage tank and reclaiming tower have often been constructed of wood but rubber-lined steel tanks are more satisfactory since they can be used at higher temperatures. Economy considerations require that the acid be as warm as possible and rubber-lined tanks are satisfactory at temperatures at least 30°F. higher than wooden tanks. Still higher temperatures can be employed if a brick sheathing is used to protect the rubber-lined equipment. Such brick, of course, is joined with suitable acidproof cement.

Some processes use a brick-lined spherical digester but today's typical digester is a tall cylindrical vessel with conical or dome-shaped top and conical bottom. The customary digester has a diameter in the order of 15 feet and is about 50 feet in height.

For calcium-base sulphite cooking, one course of $2^1/_2$ or 3-inch brick laid with a litharge-glycerine cement joint and backed by Portland cement has been satisfactory and modifications of this construction have been used for the heavier linings. However, with the soluble base pulping, resin base cements must be used for joining the brick in the course in contact with the cooking process. A fairly rapid setting furfuryl alcohol cement has been introduced for this specific purpose so that no delays are encountered while waiting for the cement to set.

Since the floor areas are usually not subjected to temperatures above 200°F., the bricks on these floors can be joined satisfactorily with a plasticized sulphur cement. However, for best results, furfuryl alcohol base cements are advocated.

The physical and chemical properties of corrosion-resistant cements of greatest interest to acid pulping are shown in the table.

Raymond B. Seymour. The Atlas Mineral Products Co., Mertztown, Pa.

Rubber

James P. McNamee

In the production of chemical pulp by the acid or sulphite process, wood chips are digested with a liquid which consists essentially of a calcium bisulphite solution containing free sulphur dioxide. The bisulphite solution is manufactured by reacting sulphur dioxide gas, obtained by burning sulphur

James P. McNamee, U. S. Rubber Co., Providence, R. I.

in air, with either a water suspension of lime (milk-of-lime) or solid limestone in large towers.

This acid liquor is very corrosive and must be handled in equipment constructed of special materials capable of resisting its corrosive action. One of these materials is rubber-lined steel. Soft rubber compositions are satisfactory with straight calcium and magnesium bisulphite solutions, but the presence of free sulphur dioxide in most sulphite liquors requires the use of hard rubber linings.

Hard rubber has not been extensively used as a material of construction in the sulphite plant due to the relatively high operating temperatures involved in most of the process lines. Regular hard rubber linings can be used at a maximum temperature of 180°F. and special compositions are available for temperatures as high as 220°F.

Within these temperature limitations hard rubber-lined steel should be considered for process and storage tanks, pipe, fittings, valves, pumps, agitators, fans, and duct-work. A $^3/_{16}$-inch thickness of lining is usually recommended for handling sulphite liquors. The rubber is applied to the metal equipment in the form of unvulcanized sheets which are then vulcanized by means of steam pressure to form a dense layer of hard rubber uniformly adhered to the steel foundation. This layer of hard rubber will adequately protect the steel from the corrosive action of the bisulphite solutions.

Plastic pipe of the Uscolite type is resistant to sulphite liquors up to a maximum service temperature of 160°F. This pipe can be ordered in stock lengths and cut to size and threaded as desired. Since a complete line of fittings is available, this material should find wide applications where chemically resistant pipe is desired.

Iron and Steel

Albert W. Spitz and Arthur E. May

Iron and steel are widely used for pulp wood and sulphur handling prior to the preparation and use of the acid cooking liquor.

Log conveyors, barkers, chippers, chip screens, and elevators of low-carbon steel and cast-iron construction are quite satisfactory.

Sulphur melters, burners, and burner gas coolers are also fabricated of these metals. Sulphur dioxide piping may be of cast iron or steel if the gas is dry, or the temperature high enough to prevent condensation. SO_2 and bisulphite solutions require the use of corrosion-resistant materials.

Brick-lined steel digesters are extensively used; however, the present trend is toward the use of more resistant alloys without brick lining.

Iron and steel are not suitable for sulphite pulp blow pits.

Knotters and screening equipment prior to the actual papermaking operations may be of iron or steel construction.

High-Silicon Irons

Walter A. Luce

The high-silicon iron alloys, Duriron and Durichlor, find no application in the handling of sulphite solutions in the pulp and paper industry. Sulphurous acid and the various sulphites are among the few corrosives which attack these alloys and this accounts for their lack of application.

Nickel, Nickel Alloys

H. O. Teeple

Cooking liquors used for acid pulping may be calcium, magnesium, or ammonium-base bisulphite liquors. Since these acid pulping liquors involve the use of solutions containing free sulphur dioxide, Monel, nickel, Inconel, and Ni-Resist find little application. Other alloys, particularly certain of the austenitic stainless steels are more resistant to corrosion by these cooking liquors, hence, are preferred for acid pulping service.

To indicate the relative position of Monel, nickel, Inconel, and Ni-Resist in comparison with other more suitable materials, the following corrosion data are shown.

Plant Corrosion Test in Collector Ring in Calcium Bisulphite Pulping Digester

Duration of Test 652 Hr., Temp. 141°C. max., 40°F Min.

Material	*Corrosion rate, in./yr.*
Type 316	0.0002
Type 317	0.0002
Type 309	0.0007
Inconel	0.023
Monel	0.19
Ni-Resist	1.0

Plant Corrosion Test—Specimens Attached to Digester Cover

28-Day Test, Temperature 291°F. Max., 143°F. Min., 7.87% Total SO_2, 6.82% Free SO_2, 1.05% Combined SO_2

Material	*Corrosion rate, in./yr.*
Type 316	0.0001
Type 317	0.0001
Hastelloy C	0.0005
Worthite	0.0001
Monel	0.62
Nickel	0.79
Inconel	0.01
Ni-Resist	0.98
Cast iron	1.8
Mild steel	10.9

It is to be noted, however, that once the spent acid cooking liquor has been removed from the sulphite stock, Monel, nickel, Inconel, and Ni-Resist are quite useful as described in part I of this symposium, stock handling.

Chlorimets

Walter A. Luce

The Chlorimet alloys find no application in the sulphite process for making pulp.

Stoneware

M. J Winson

In the acid pulping operations encountered in the pulp and paper industry, corrosion is quite a problem. This problem has been effectively combated by the use of corrosionproof chemical stoneware and chemical porcelain, and in many instances, plastic; pipes, valves, fittings, pumps, and vessels. Cast modified phenolic equipment known as Kemplas No. 1 is resistant to the sulphurous acid solutions used in acid pulping. For corrosionproof service at any concentration up to 250°F., modern high-strength chemical porcelain is superseding the weaker chemical stoneware. A new material of construction for acid pulping is plastic armored chemical porcelain, in which the internal thermal shock resistance, external physical shock resistance, and safety features are greatly enhanced.

Albert W. Spitz, Reiter Engineering Co., Philadelphia, Pa., and Arthur E. May, Moore and White Co., Philadelphia, Pa.

Walter A. Luce, The Duriron Co., Dayton, Ohio.

H. O. Teeple, International Nickel Co., New York. N. Y.

Walter A. Luce, The Duriron Co., Dayton, Ohio.

M. J. Winson, General Ceramics and Steatite Corp., Keasbey, N. J.

Durimet 20

Walter A. Luce

Stainless steels are commonly accepted as the most suitable alloys for use in the sulphite process for pulp and paper production and, therefore, find wide application in this industry in both the cast and wrought forms. The need for these alloys results from the continuous handling of sulphurous acid and various sulphite solutions which are often encountered at high conconcentrations and elevated temperatures. Although the conventional 18% chromium–8% nickel alloys and the 29% chromium–9% nickel alloys find the greatest application, there is a definite advantage in many services for a higher alloyed stainless steel such as Durimet 20.

The pulp and paper industry has always been progressive and this outlook has been reflected into their continual selection of more suitable and more economical alloys in the pulping stage. Sulphite pulping is, of course, particularly severe and it is in this type mill that continual progress in materials was necessary. Numerous corrosion data have been published on the comparative resistance of the various stainless alloys, but these data often do not show any superiority of the highly alloyed stainless steels, such as Durimet, over the more conventional stainless alloys. However, it has been found from experience that other important factors, such as solution velocity or erosion, cannot be estimated from static tests. Therefore, Durimet 20 is being applied in these services to a greater extent as pumps, valves, and special fittings. In fact, it is being used in certain services where a supposedly satisfactory service life from these other alloys was being received. Its selection resulted in an added factor of safety which more than offsets its slightly higher initial cost.

Durimet 20 is a highly alloyed stainless steel with a nominal chemical composition in the cast form of 29% Ni, 20 Cr, 2 Mo, 3.5 Cu, 1 Si, 0.07 C max., and balance Fe. It is available in the form of castings and equipment made from castings, such as pumps, valves, fans, ejectors, jets, and mixing nozzles. The wrought form of this alloy is produced by the Carpenter Steel Co., under the name Carpenter Stainless No. 20. Presently, the wrought alloy is available in the form of wire, rod, bar, strip, sheet, plate, welded pipe, and tubing. Welding electrodes in the Durimet 20 analysis are also available.

The use of Durimet 20 in sulphite pulping extends throughout the acid plant and the digester room. Many of the present applications for this alloy in both these locations will be cited below. Carpenter 20 pipe and Durimet 20 fittings are being applied in a test installation at one plant for the pond type coolers handling hot sulphur dioxide gas from the combustion chamber. This service is extremely severe at certain locations where the presence of small percentages of sulphur trioxide and moisture at a temperautre just below the dew point results in the formation of sulphuric acid. The temperature involved is very high. After a substantial test duration, this alloy appears to offer acceptable resistance where previous alloys failed. Durimet 20 and Carpenter 20 have also found applications in the fan which handles the cooled sulphur dioxide gas from the cooler to the absorption or acid towers. In the spray-type cooling towers, Durimet 20 nozzles are also being used.

Durimet pumps and valves are being applied for recirculating both the weak and strong acid solutions from the weak and finished acid towers, respectively. Two pumps are alternately handling weak and strong sulphurous acid and have been in operation in the production of calcium bisulphite since 1941. Other Durimet pumps in this same type service are providing well over 15 years' continuous service. Durimet Y valves are being successfully used in the acid plant for handling these same solutions with good success. It has been reported that Durimet is especially desirable in the production and use of the ammonium bisulphite liquor.

The Durimet 20 alloy is also finding application in the digester room. Not only are Durimet pumps and valves being used to handle the cooking liquor to the digesters, but Durimet 20 castings are also utilized for critical parts in the digester itself. Castings in Durimet include top sleeves, Panzl, and other type strainers, test fittings, elbows, cast pipe, steam inlets, and nozzles, bottom sleeves, blow-off fittings, and others. Relief valves have been made from Durimet with the top relief valve being especially critical since it handles a corrosive combination of sulphurous acid and products from the wood, both under oxidizing conditions and at very high temperatures. Durimet Y valves and plug valves are very well adapted for this severe service. Durimet valves have found applications as test cocks on the digesters. The recently announced Durco Type F valve and Teflon liner is extremely well suited for this service and in test installations, it is providing superior service over other valves previously used. The Durimet 20 alloy has found application as circulating system pumps. Pumps in this alloy are also being applied for handling spent cooking liquor for leveling off the pulp in the blow pits. Durimet is finding application as a material for the target plates in the blow pits.

The above services illustrate the uses to which Durimet 20 is being applied in sulphite pulping. As noted previously, the Durimet 20 alloy is usually selected where high velocity conditions exist, such as in pumps and valves or where the presence of small percentages of sulphuric acid are encountered. It is suspected by many experts that small percentages of sulphuric acid may be encountered in the digester system, especially during shutdowns and if this is the case, the value of Durimet 20 may be more desirable than first anticipated. However, it should be pointed out that even Durimet 20 has its limitations in sulphuric acid service and it should be carefully considered for the more severe conditions.

Durimet 20 also finds application in sections of the sulphite process other than the acid plant and digester room. For instance, waste calcium bisulphite liquors are processed by a few companies for the by-products they contain. Durimet 20 pumps are being used successfully in such operations.

Part IV—Alkaline Pulping

Worthite

W. E. Pratt

The alkaline pulping processes employed in the paper industry are: (1) the soda process, (2) the sulphate (kraft) process, and (3) the semichemical process—based on one of the above.

The percentage of pulp made by these processes has been increasing by leaps and bounds in the last decade. The big boost for the sulphate process followed the successful development for pulping southern pine although many other woods are now processed by this method.

The corrosion problems in the straight soda process are relatively mild. The sulphate process is essentially the same up to the smelt furnace where sodium sulphate (Na_2SO_4) is added which supplies the sodium sulphide (Na_2S)—the important active agent in the digester liquor. It was not recognized at first by many in the industry that the presence of Na_2S in the black liquor would increase the corrosive action on iron and steel to a marked degree, with the result that hundreds of thousands of dollars worth of equipment failed in service and had to be replaced by more resistant materials. Many of the older soda pulp mills are now adding small

W. E. Pratt, Worthington Pump and Machinery Corp., Harrison, N. J.

amounts of sulphate in recovery operations, so their corrosive problems are now on the increase.

Worthite is one of the alloys that shows practically perfect resistance to the corrosive action of the sulphate digester liquors. Worthite also is highly resistant to the corrosive-erosive conditions existing in the handling of the black liquor-salt cake slurries for the furnace feed, and to the various abrasive slurries encountered in the recausticizing plant.

Typical of the results of early tests on Worthite for handling the black liquor encountered in the recovery plants in these processes, is this report: "A pulp mill exposed a specimen of Worthite to black liquor in the dehydrator, at 300° F. for 55 days and reported no loss."

This test led to the use of Worthite pumps in this plant on all black liquor, green liquor, and white liquor services. The plant now has purchased over the last 12 years a total of 78 Worthite pumps.

The pump that feeds the concentrated black liquor, mixed with salt cake, to the smelting furnace, is not subjected to the corrosive Na_2S which is formed in the furnace. The service is especially severe, however, due to the presence of the abrasive salt cake crystals. Worthington developed a special pump for this service about 15 years ago and it has been used in over 90% of all installations made since that time. Casings are of tough nickel iron. Impellers made of steel, 13% chrome stainless steel, 18–8 stainless steel, Monel, and finally Worthite were tried out. Worthite has been standard for the last 10 years as it not only gives the longest service (3 to 8 years) but it costs less per year of service. This record on Worthite impellers has led some mills to use all-Worthite pumps for the furnace feed.

Other services in alkaline pulp, black liquor recovery plants for which Worthite pumps are widely used are: (1) evaporators—feed, transfer, discharge, condensate; (2) black liquor —to and from the cascade, pulp washers, spray-circulator, blow pit stock, ash removal, and for alloy-internal pump parts for weak black liquor of less than 15% solids; (3) green liquor —dissolving tank circulators and transfer; (4) lime mud; (5) causticized liquor slurry; (6) white liquor—to clarifier, transfer and filling; (7) dregs washer; (8) clarifier underflow mud; (9) filter feed; black ash leaching—washer circulating; and (10) carbon washers circulating.

Worthite pumps are considered by users to be more economical than "sand pumps" made of very hard metals, for some of the above slurry services. While Worthite is not a hard metal, it is exceedingly tough, and with its superior corrosion resistance it actually does give excellent results if the pumps are properly applied and operated. By this is meant that the pump must: (1) be supplied with the slurry in proper suspension, (2) have a static suction head that prevents air entering the suction line, (3) be provided with the required NPSH, (4) not be required to handle high percentages of solids larger than 50 mesh, and (5) be of a size that permits operation near the capacity represented by the maximum efficiency point. This latter is most important for long life as otherwise cavitation or churning (eddy losses) will greatly reduce the useful life.

Carbon

L. C. Werking

Carbon linings for alkaline pulp digesters have been used since 1931. The use of these linings affords positive protection to mild steel digesters under present-day operating conditions, which have made the use of unprotected shells impractical from the corrosion standpoint.

As carbon brick is completely resistant to chemical attack and rarely subject to spalling, life in the order of 15 years has been observed.

Since 1931, 45 carbon brick linings have been (or are about to be) applied to digesters, both riveted and welded, in all the known modifications of alkaline cooking and alternate alkaline and neutral cooking.

Practically all linings installed prior to 1948 employ a thickness of 5 inches. More recent installations use newly developed, high-compressive strength brick which are laid to give a 3-inch thickness without sacrifice of strength or chemical resistance.

Extensive inspections demonstrate that carbon linings can be expected to give complete protection to digester shells in all alkaline pulping processes currently in use.

Cements

Raymond B. Seymour

Because of the general opinion that steel is completely resistant to alkalis, progress in combating corrosion in the sulphate and kraft processes through the application of corrosion-resistant cements has been much slower than in the sulphite process. However, operators who have studied the life of unprotected iron shells have concluded that sound economics demands that alkaline pulping process digesters be protected. Unfortunately, shale bricks are not completely satisfactory for alkaline service but carbon bricks joined with modern furfuryl alcohol resin cements appear to be completely satisfactory for the sulphate process. Cements based on silicates, sulphur, phenolic resins, and glycerine-litharge are completely unsatisfactory for alkaline service.

Part of an alleged decrease in resistance of unprotected carbon steel digester shells has resulted possibly from changes in corrosion rates of the process rather than from a decrease in the corrosion resistance of steel. Recent studies have shown that the use of carbon brick joined with furfuryl alcohol resin cements increases the cost of a digester by less than 50% but prolongs the life expectancy by at least 100%. The cost of stainless steel is about double the cost of a carbon steel digester and considerably more than carbon brick-lined digesters joined with properly selected cements.

Furfuryl alcohol resin cements are usually prepared by mixing two parts by weight of powder with one part by weight of the liquid resin and the resulting cement gives excellent adhesion to carbon brick. The working time of these cements varies from 90 minutes at 60° to 15 minutes at 90°. These cements are completely cured and ready for alkaline service after 3 days at 70°F. They have a coefficient of expansion of $6 \times {}^{-6}$, a water absorption of less than 0.4%, and are completely resistant to caustic in all concentrations at temperatures up to 380°F.

Durimet 20

Walter A. Luce

Durimet 20 has not found the same application in alkaline pulping processes (either soda or kraft) that it has in the acid pulping process described in the previous part of this symposium. The reason for this limited use of Durimet 20 is that the corrosive conditions are not as severe in the alkaline process and consequently such materials as steel, chrome steel, and the conventional 18–8 S stainless steels have found successful application for most of the services encountered. However, there are specific services, especially those in the black liquor recovery system, that are extremely destructive. The trend is to incorporate more resistant materials of construction for these special services and the supe-

L. C. Werking, National Carbon Div., Union Carbide and Carbon Corp., New York, N. Y.

Raymond B. Seymour, Atlas Mineral Products Co., Mertztown, Pa.

Walter A. Luce, The Duriron Co., Dayton, Ohio.

rior corrosion and erosion resistance of the higher alloyed stainless steels, such as Durimet 20, makes them an economical selection.

For the most part these superior stainless steels are used as pumps and valves where this increased resistance to erosion-corrosion is beneficial. For instance, these pumps are used in kraft mills for handling all solutions in the recovery system. In certain locations the conditions are necessarily move severe due to the presence of abrasive materials in the system. In fact, one Durimet 20 pump was made with a Chlorimet 3 (Nickel base alloy containing 18% Cr and 18% Mo) impeller to obtain even greater erosion resistance to the lime slurry from the slaking tank. In this latter service, impellers made from the Durimet 20 type alloy were eroded in 6 months while steel provided less than three months' service. Durimet 20 plug valves are also being used for certain services in the black liquor recovery process where steel valves were generally unsatisfactory.

Durimet 20 has a nominal chemical composition in the cast form of 29% Ni, 20 Cr, 2 Mo, 3.5 Cu, 1 Si, 0.07 C max., and balance Fe. It is available in the form of castings and equipment from castings such as pumps, valves, fans, ejectors, jets, and mixing nozzles. The wrought form of this alloy is produced by the Carpenter Steel Co. under the name Carpenter Stainless No. 20. Presently the wrought alloy is available in the form of wire, rod, bar, strip, sheet, plate, welded pipe, and tubing. Welding electrodes in this analysis are also available.

High-Silicon Irons

Walter A. Luce

The high-silicon iron alloys find practically no application in the soda pulp or kraft processes because of the satisfactory service of other alloys, such as steel, chrome steels, and others. Generally, the high-silicon iron alloys provide no advantage over cast iron and steel in alkaline solutions and this, of course, restricts their use.

Duriron is a high-silicon iron alloy containing 14.5% Si, 0.75 Mn, 0.90 C, and balance Fe. It has good erosion resistance due to its extreme hardness (520 Brinell) and therefore, has found a very limited application in alkaline pulping to handle severe erosion services. For instance, a Duriron pump was used by one soda pulp mill to handle the lime slurry from the bottom of the slaking tank and is providing satisfactory service after more than 2 years' continuous operation. One other mill reports good service from a Duriron pump on black liquor. This is another erosion service due to the presence of abrasive wood products from the digester. In these severe erosion or abrasion services, Duriron has proved to be an economical selection.

Because of the afore-mentioned hardness, any machining on Duriron must be accomplished by grinding methods. Nevertheless, this alloy is available in many forms of chemical equipment, such as pumps, valves, ejectors, pipe, tank outlets, jets, fans, and spray nozzles. Durichlor contains 3% Mo in addition to the Duriron analysis, but this provides no superiority for alkaline solutions.

Chlorimets

Walter A. Luce

Chlorimet 2 (63% Ni, 32 Mo) and Chlorimet 3 (60% Ni, 18 Cr, 18 Mo) find practically no application in alkaline pulping. These alloys are economical only for very severe services where other less expensive alloys will not suffice. However, many plant men are becoming more conscious of the severe erosion-corrosion problems in their mills and are investigating the use of the higher alloys. In one mill a Chlorimet 3 impeller was substituted for Durimet 20 in a pump to handle a lime slurry from the slaking tank. Impellers in the latter type alloy only provided six months' service before being severely eroded. The superior erosion resistance of Chlorimet 3 should considerably extend this service life. Chlorimet 2 has not been used in any phase of alkaline pulping.

Iron and Steel

Arthur E. May and Albert W. Spitz

Iron and steel are extensively used in alkaline pulping and were at one time used exclusively.

As in sulphite pulping, log conveyors, barkers, chippers, chip screens, and elevators of low-carbon steel and cast iron are quite satisfactory.

In the digester room, liquor storage tanks, digesters, pumps, liquor heaters, heat exchange equipment, and piping are generally made of carbon steel and cast iron. In recent years, however, digesters of stainless clad construction have somewhat replaced carbon steel, and stainless sheet has been used to extend the life of existing carbon steel digesters.

Carbon steel piping and all iron valves are predominantly used for white and black liquor. In some instances, the use of more resistant materials for black liquor handling may prove most economical.

Cyclone separators, heat reclaiming equipment, and blow tanks of carbon steel are satisfactory.

Cast iron and carbon steel are acceptable for constructing knotters and screening equipment prior to the actual paper-making operations.

In the evaporation and chemical recovery step, black liquor storage tanks, multiple effect evaporators (except for one stage which is generally stainless steel), and disk evaporators are of carbon steel construction.

Smelt dissolving tanks, piping, and valves were formerly made of cast iron and carbon steel; more resistant alloys are now used.

In the causticizing system carbon steel equipment is satisfactory for clarifiers, lime storage and handling equipment, slakers, causticizers, sludge washers, and the lime burner shell. In general, the corrosion problems in this step are minor.

Rubber

James P. McNamee

The manufacture of paper by both the soda process and kraft (sulphate) process comes under the classification of alkaline pulping. Neither of these processes involves extreme corrosion conditions and as a result, rubber-lined steel has not found extensive application as a material of construction in these plants. Both soft and hard rubber-lined steel are unaffected by the various digesting liquors and by-product liquors used in the alkaline pulping operations, however, and may be used where metal protection is desired.

Rubber linings can be applied to process and storage tanks, pipe, fittings, valves, pumps, and agitators. Soft rubber can be used at temperatures below 150°F. and hard rubber will operate as high as 180° for regular grades and 220°F. for special grades. Sheet neoprene linings are resistant to strong sodium hydroxide solutions at elevated temperatures and are particularly adapted for transportation equipment where strong caustic must be heated in order to remove it from the tank.

Solid plastic pipe is resistant to alkalis and may be used to handle sodium hydroxide solutions. This type of pipe is very convenient to use since it can be purchased in stock lengths and cut to size in the same manner as steel pipe.

Arthur E. May, Moore and White Co., Philadelphia, Pa., and Albert W. Spitz, Reiter Engineering Co., Philadelphia, Pa.

James P. McNamee, U. S. Rubber Co., Providence, R. I.

Nickel, Nickel Alloys

H. O. Teeple

GENERALLY speaking, the corrosion problems encountered in soda pulping are not severe.

Carbon steel, for example, has proved to be economically suitable for soda digesters and in some mills, service lives up to 30 or 40 years have been achieved.

In some critical services, Ni-Resist has replaced cast iron, particularly pumps and valves. For example, Ni-Resist digester blow valves have been used with good results. An important application of Monel in soda pulping is the use of Monel for black liquor evaporator tubes, particularly in the strong liquor effects. The following data indicate the suitability of Monel for this purpose:

Corrosion of Black Liquor Evaporator Tubes—Soda Process

Plant Corrosion Test for 57 Days in 55% Solids Soda Black Liquor. Specimens Submerged in First Effect Evaporator. Temperature 222°F.

Material	*Corrosion rate, in./yr.*
Monel	0.006
Carbon steel	0.064

Other useful applications of Monel are in handling green liquor and in lime sludge filters for filter elements and wire cloth covers. The latter use of Monel is particularly effective because of frequent cleaning of the filters with hydrochloric acid.

The corrosion problems arising through the use of a sulphate cooking liquor are generally more severe than those of the soda process. These problems assume major importance because of the extensive use of the kraft process all over the United States and Canada.

By and large within the space of the last 5 to 8 years a great many mills have encountered serious digester corrosion problems. The point is that formerly carbon steel digesters would last 10 to 20 years and recently, service life has decreased to the order of 3 to 5 years. The prime reason for the noted increase in corrosion of the digesters is obscure at the moment. Undoubtedly there are several contributing factors responsible for decreased digester service life. Some of these factors are real and capable of evaluation.

The current approach to this problem by many pulp mill people appears to be in the direction of using a digester lining of some suitably resistant material. This approach includes the use of shop or field applied linings which might be an alloy or an alkali-resistant brick such as carbon brick. It includes also the use of alloy clad steel plates.

As far as Monel, nickel, and Inconel are concerned for sulphate digester service, the only one possessing sufficient resistance to corrosion by the alkaline sulphide cooking liquor is Inconel. The resistance of Inconel to corrosion by kraft cooking liquors is quite high, being of the order of 0.0005 i.p.y. Other properties of Inconel permit its use as a resistance welded, shop-applied lining or as a clad steel. Inconel also has two very strong important properties which are conducive to the use of this alloy for field applied linings to existing digesters. One of these properties is that its thermal coefficient of expansion is practically the same as that of carbon steel, thus high internal stress levels do not occur during the normal working of a digester. The other important factor is that tests have shown Inconel is not subject to embrittlement by hot concentrated white liquor or mixtures of white and black liquors, i.e., cooking liquors. These two important factors coupled with the favorable welding characteristics of this alloy place Inconel in an outstanding position for sulphate digester linints.

H. O. TEEPLE, International Nickel Co., New York, N. Y.

Corrosion in Cooking Liquor Service—Sulphate Process

Material	*Corrosion rate, in./yr.*
A. Plant Corrosion Test for 35 Days on Liquor Side of Indirect Sulphate Liquor Heater at an Average Temperature of 300°F. Liquor Velocity 4 F.P.S.	
Inconel	0.0003
Mild steel	0.077
B. Plant Corrosion Test for 31 Days in Blow End of Rotating Kraft Digester Cooking 90% Hemlock and 10% Spruce. Temperature 350°F. Max.	
Inconel	0.0007
Mild steel	0.0011
C. Plant Corrosion Test for 31 Days in Blow End of Rotating Kraft Digester Cooking Western Red Cedar. Temperature 350°F. Max.	
Inconel	0.0009
Mild steel	0.056
D. Plant Corrosion Test for 310 Days in a West Coast Sulphate Digester	
Inconel	0.0006

In the liquor recovery systems in the sulphate pulping industry, Inconel is quite suitable for black liquor evaporator tubes as the following corrosion data will exemplify:

Corrosion of Black Liquor Evaporator Tubes—Sulphate Process

Plant Corrosion Test for 68 Days in Finishing Effect. Specimens Fastened to the Upper Tube Sheet. Temperature 258°F.

Material	*Corrosion rate, in./yr.*
Inconel	0.0001
Monel	0.009
Nickel	0.056
Mild steel	0.002

As in the case of soda pulping, Monel is quite useful in handling green liquors and in the causticizing of the green liquor. The following corrosion data illustrate the usefulness of Monel for these applications:

Corrosion in Green Liquor

Plant Corrosion Test of 90 Days' Duration. Specimens Immersed in Sulphate Green, Liquor Distribution Box. Temperature 180–200°F. Liquor Composed of 180 G./L. Total Alkali as Na_2CO_3, 20 G./L. as Na_2SO_4 20–25% of Total Alkali as Na_2S

Material	*Corrosion rate, in./yr.*
Monel	0.0003
Nickel	0.0004
Inconel	0.0001
Ni-Resist	0.0025

Corrosion in Causticizing Unit

Plant Corrosion Test of 35 Days' Duration. Specimens Immersed in Dorr Agitator in Causticizing Unit for Sulphate Green Liquor. Liquor Composed of 86 G./L. NaOH as Na_2O, 25 G./L. as Na_2CO_3 31 G./L. Na_2S, Some $CaCO_3$ Sludge and Some Silica. Temperature 190–200°F.

Material	*Corrosion rate, in./yr.*
Monel	0.0008
Nickel	0.0002
Inconel	0.0001

Monel, nickel, Inconel, and Ni-Resist find useful application in alkaline pulping and in a great many instances they have proved themselves to be the most economical material choices.

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Calendar of TAPPI Meetings

NATIONAL

Third Coating Conference, Sherman Hotel, Chicago, Ill., May 5–8, 1952.

Seventh Engineering Conference, Morrison Hotel, Chicago, Ill., October 13–16, 1952.

Alkaline Pulping Conference, Mobile, Ala., November 12–14, 1952 (Tentative)

LOCAL SECTIONS

Lake Erie Section:
April 18, 1952, Hickory Grill, Cleveland, Ohio

Delaware Valley Section:
March 27, 1952, Engineer's Club, Philadelphia, Pa.

Ohio Section:
April 8, 1952, Chillicothe, Ohio

New England Section:
March 21, 1952, Fitchburg, Mass.
May 16–17, 1952, Toy Town Tavern, Winchenden, Mass.

Pacific Section:
March 21, 1952, Camas, Wash.

Empire State Section:
(Western District) April 3, 1952, Niagara Falls, N. Y.
(Eastern District) March 20, 1952, So. Glens Falls, N. Y.
(Central District) April 4, 1952, Syracuse, N. Y.
(Northern District) April 10, 1952, Watertown, N. Y.
(Metropolitan District) April 15, 1952, Fraunces Tavern, New York, N. Y.
Annual Meeting, June 18–21, 1952. General Brock Hotel, Niagara Falls, Ont.

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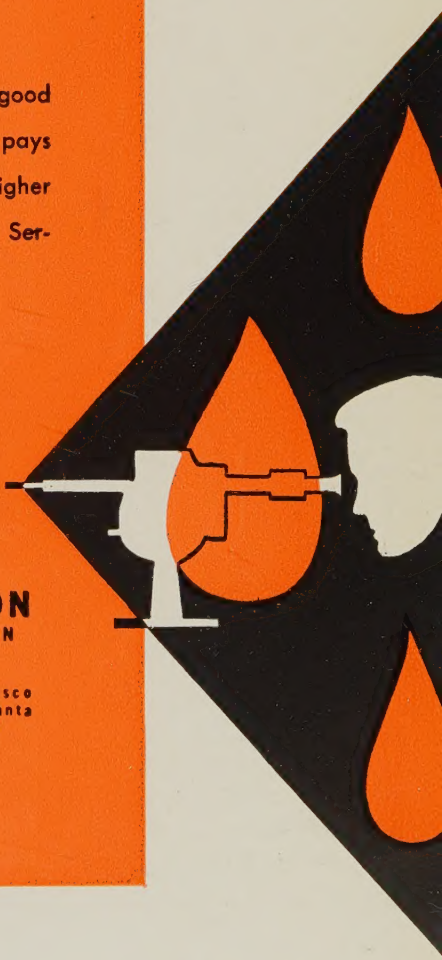

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